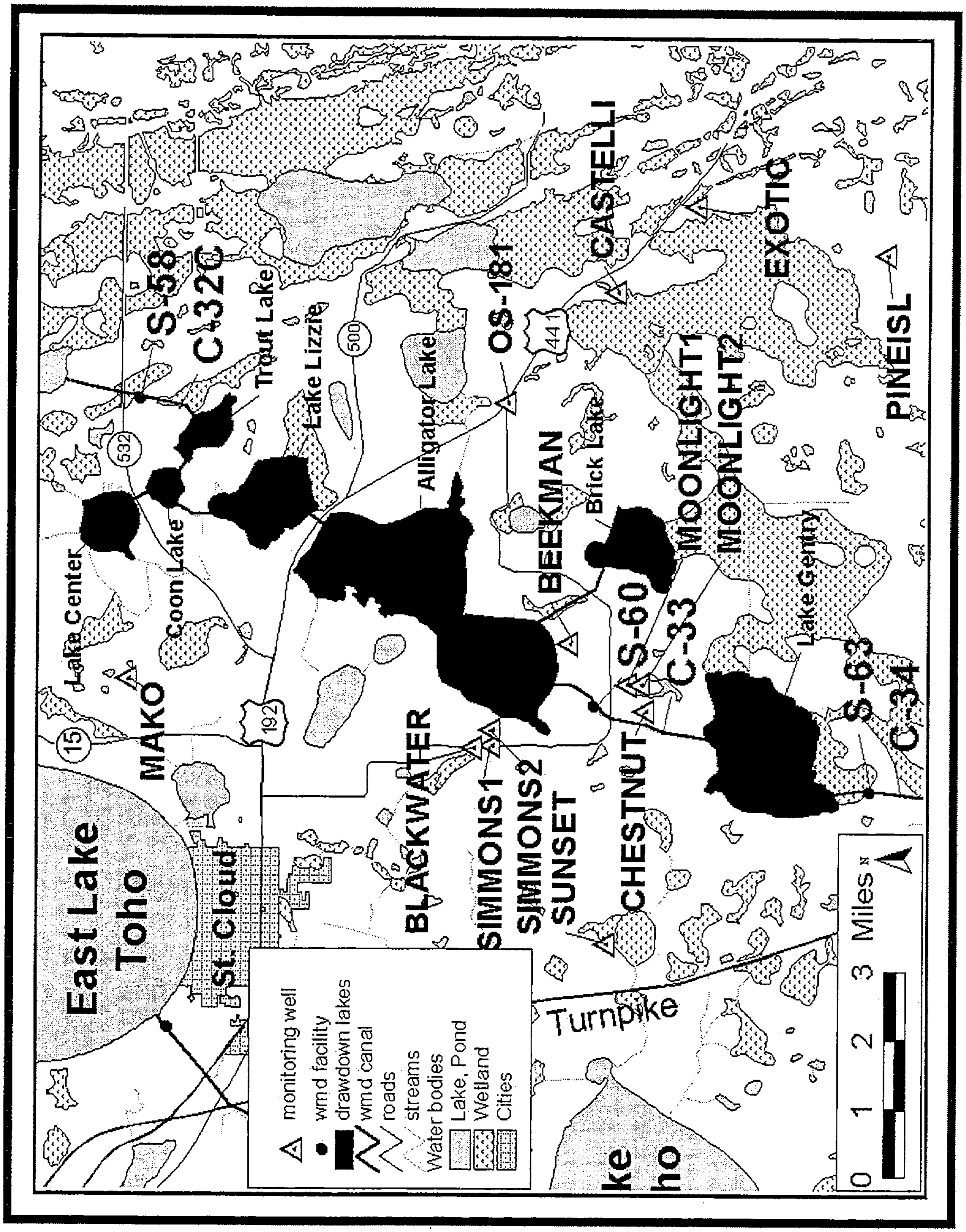
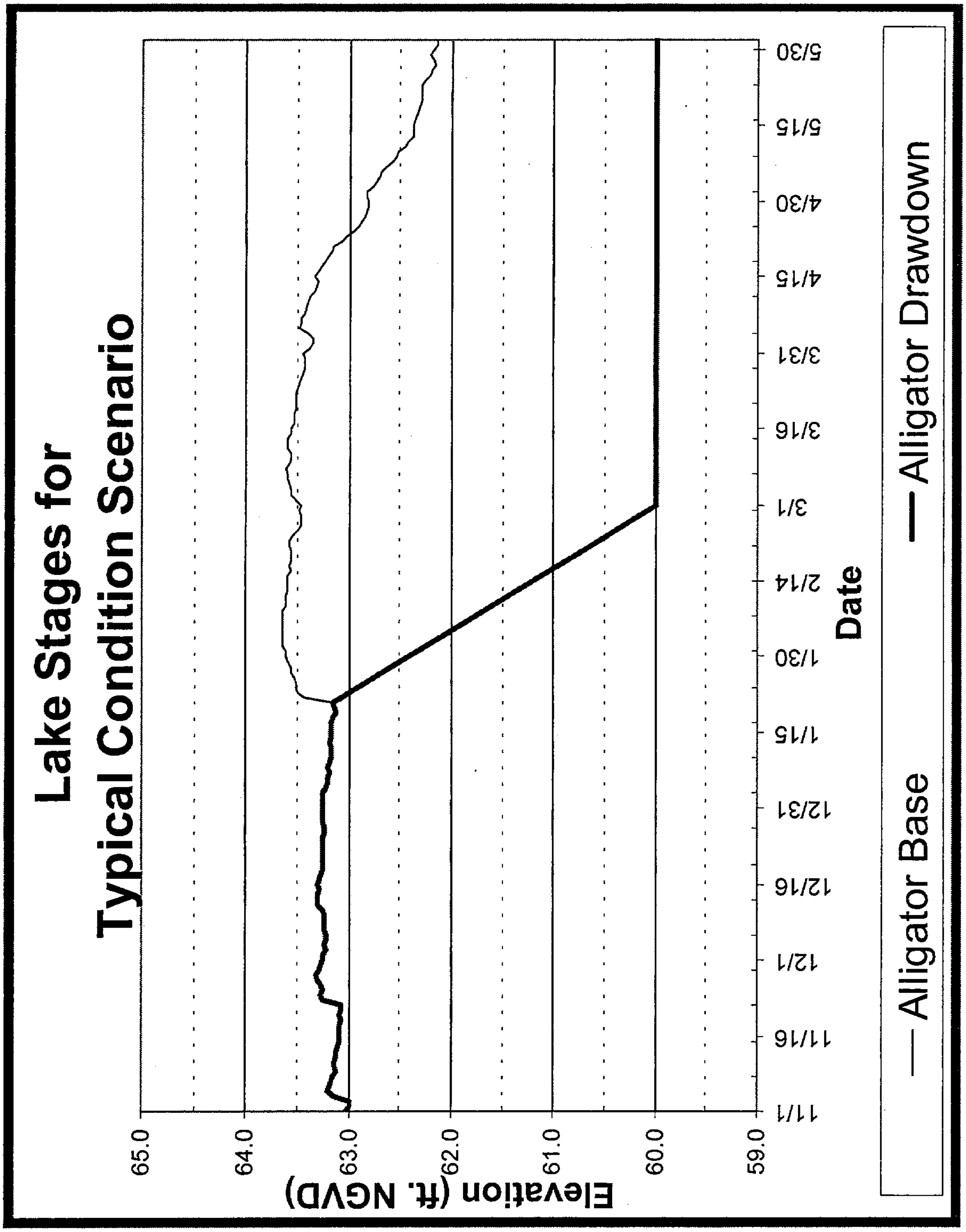
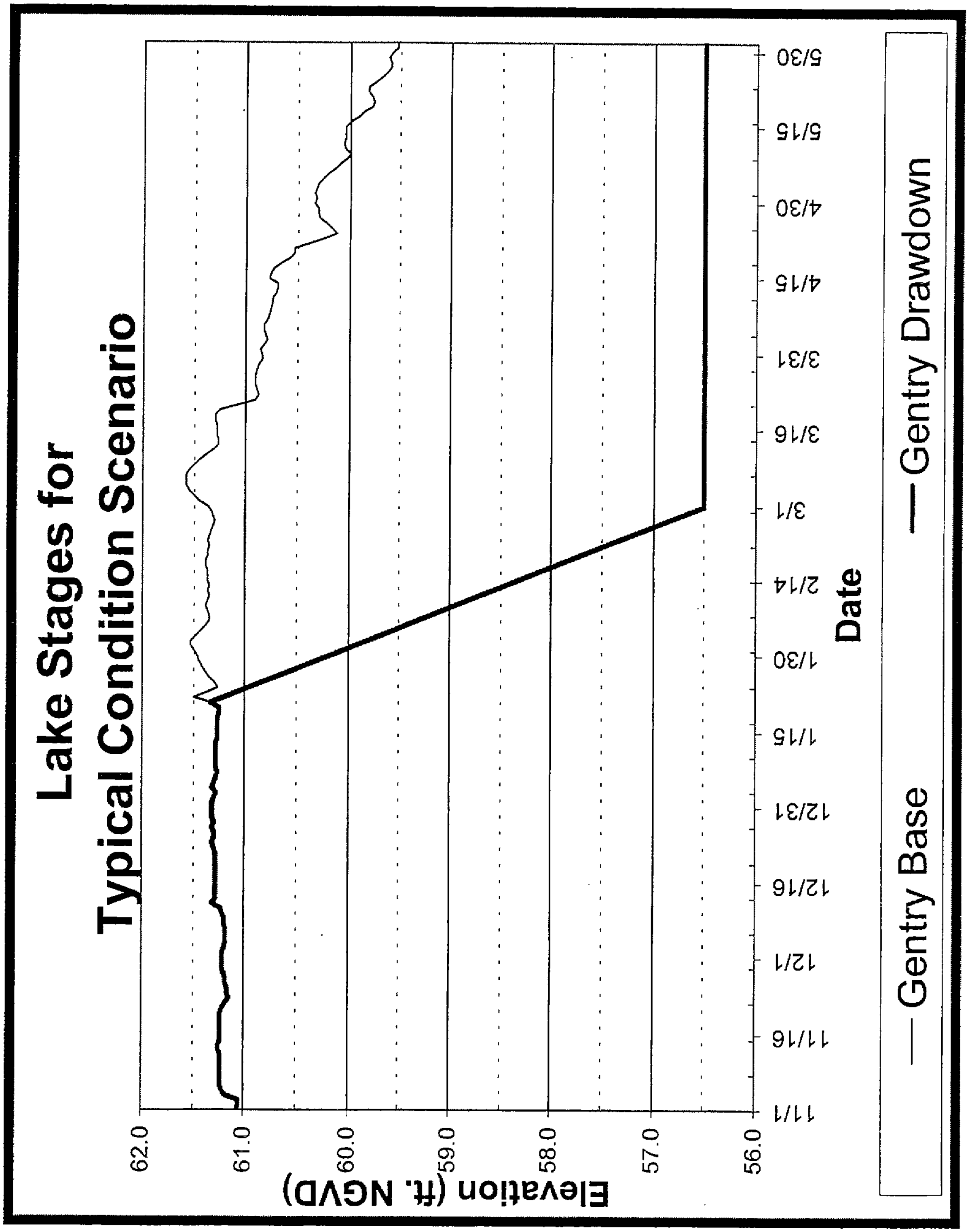
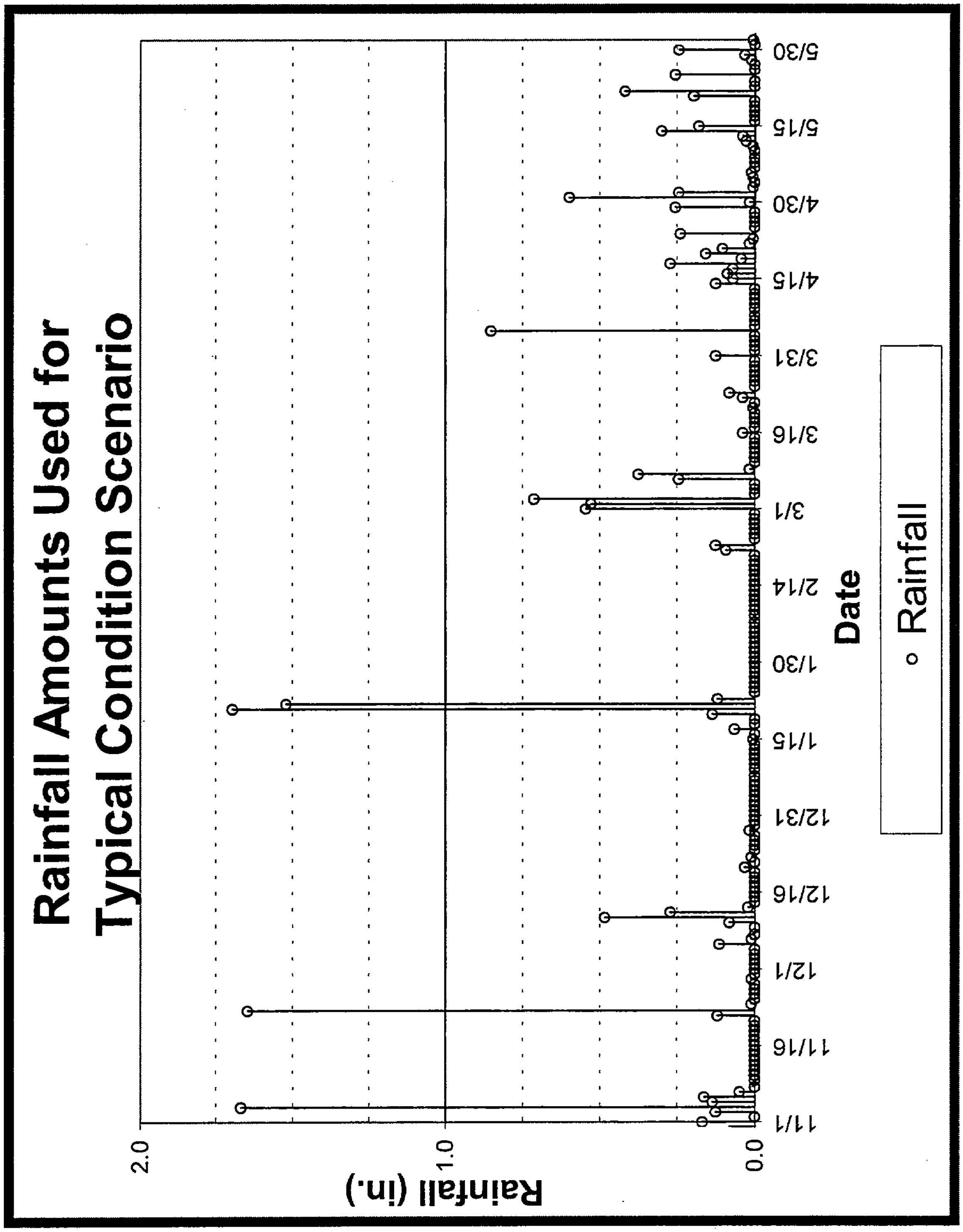
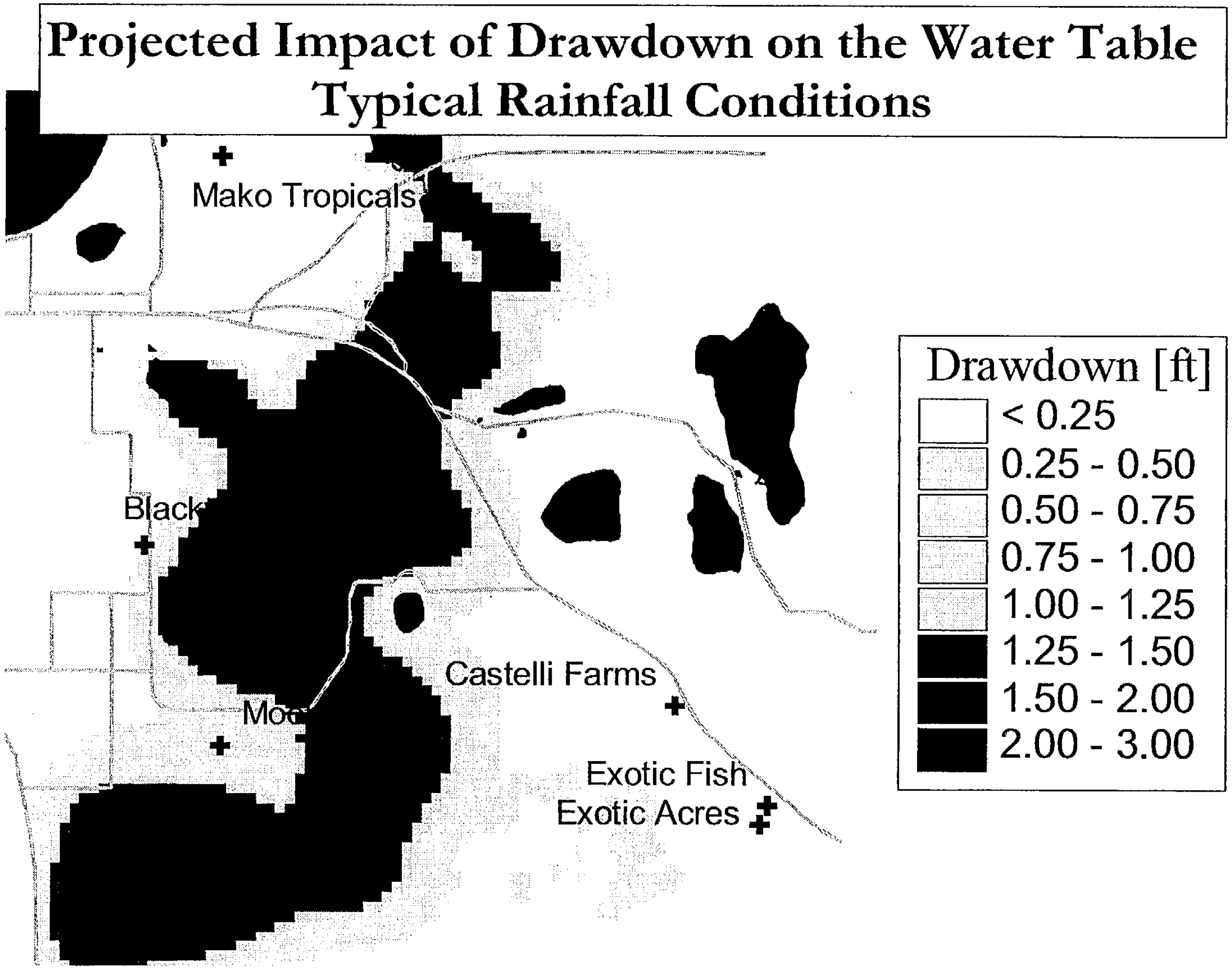


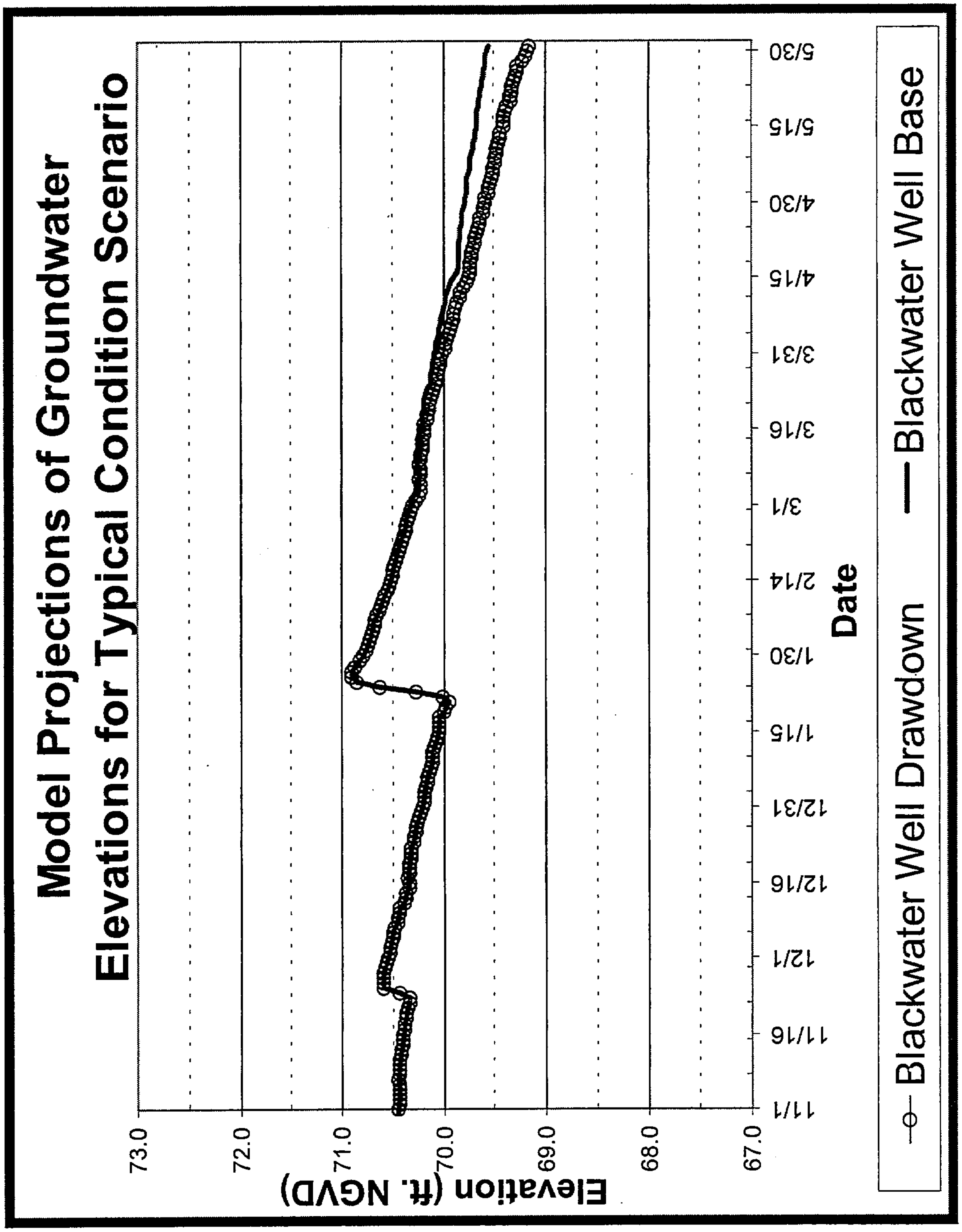
East Lake Toho
St Cloud
MAKO
Lake Center
Coon Lake
15
192
532
500
441
S-58
C-32C
Trout Lake
Lake Lizzie
Alligator Lake
OS-181
CASTELLI
EXOTIC
PINEISL
BEEKMAN
Brick Lake
MOONLIGHT1
MOONLIGHT2
Lake Gentry
S-60
C-33
S-63
C-34
BLACKWATER
SIMMONS1
SIMMONS2
SUNSET
CHESTNUT
Turnpike
monitoring well
wmd facility
drawdown lakes
wmd canal
roads
streams
Water bodies
Lake, Pond
Wetland
Cities
0 1 2 3 Miles
N

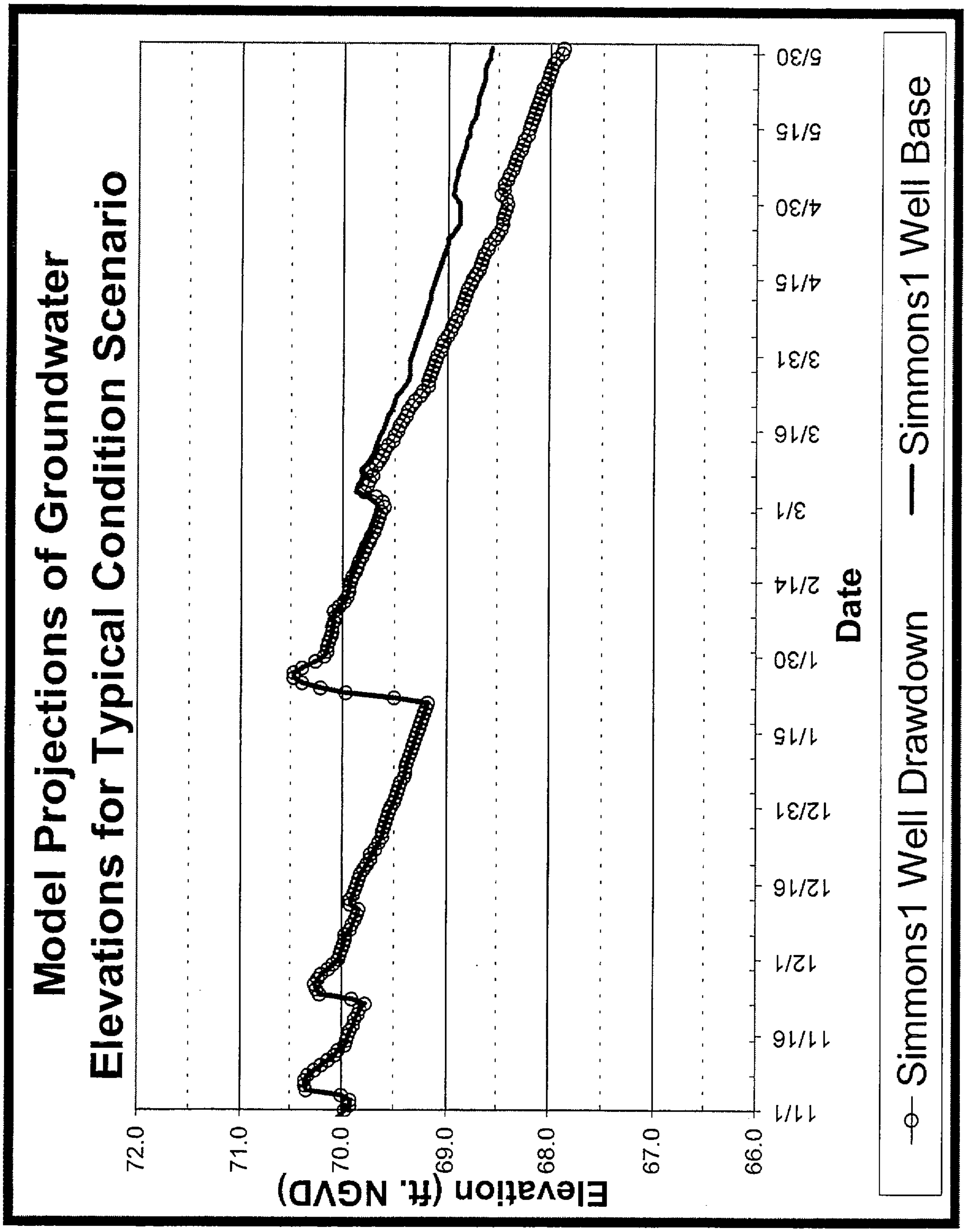

Lake Stages for
Typical Condition Scenario
Elevation (ft. NGVD)
65.0
64.0
63.0
62.0
61.0
60.0
59.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
— Alligator Base
— Alligator Drawdown

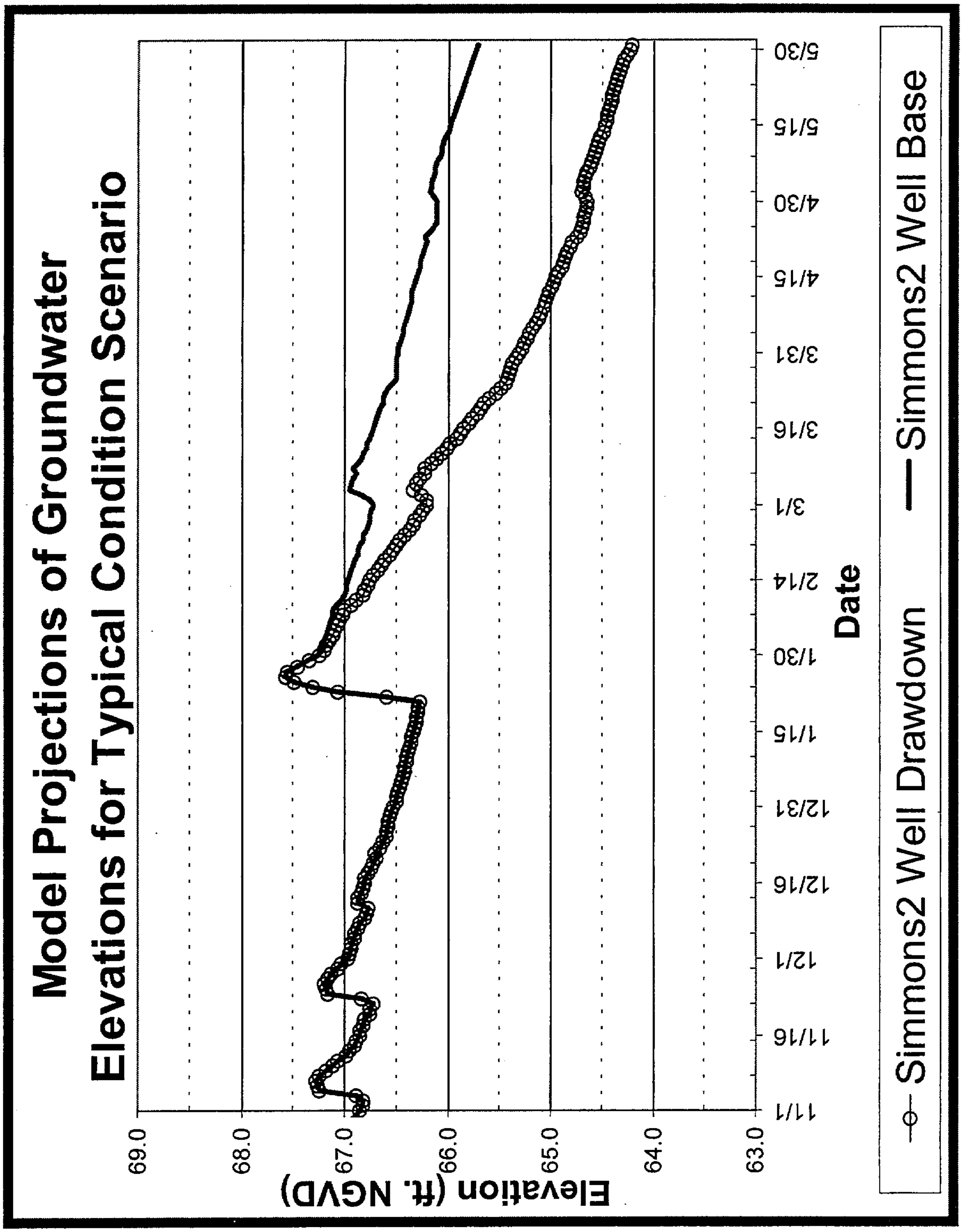

Lake Stages for
Typical Condition Scenario
Elevation (ft. NGVD)
62.0
61.0
60.0
59.0
58.0
57.0
56.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
— Gentry Base
— Gentry Drawdown

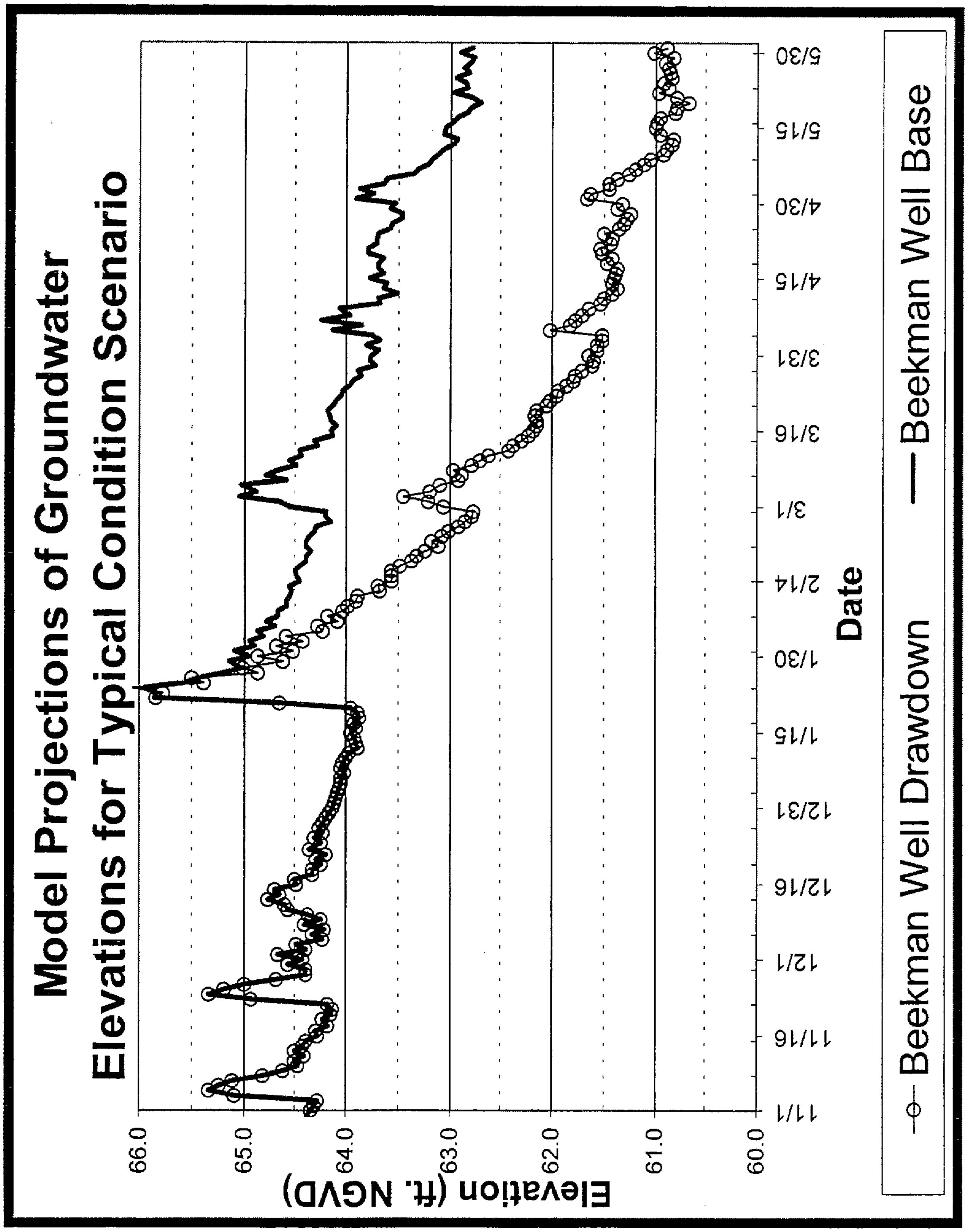

Rainfall Amounts Used for
Typical Condition Scenario
Rainfall (in.)
2.0
1.0
0.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Rainfall

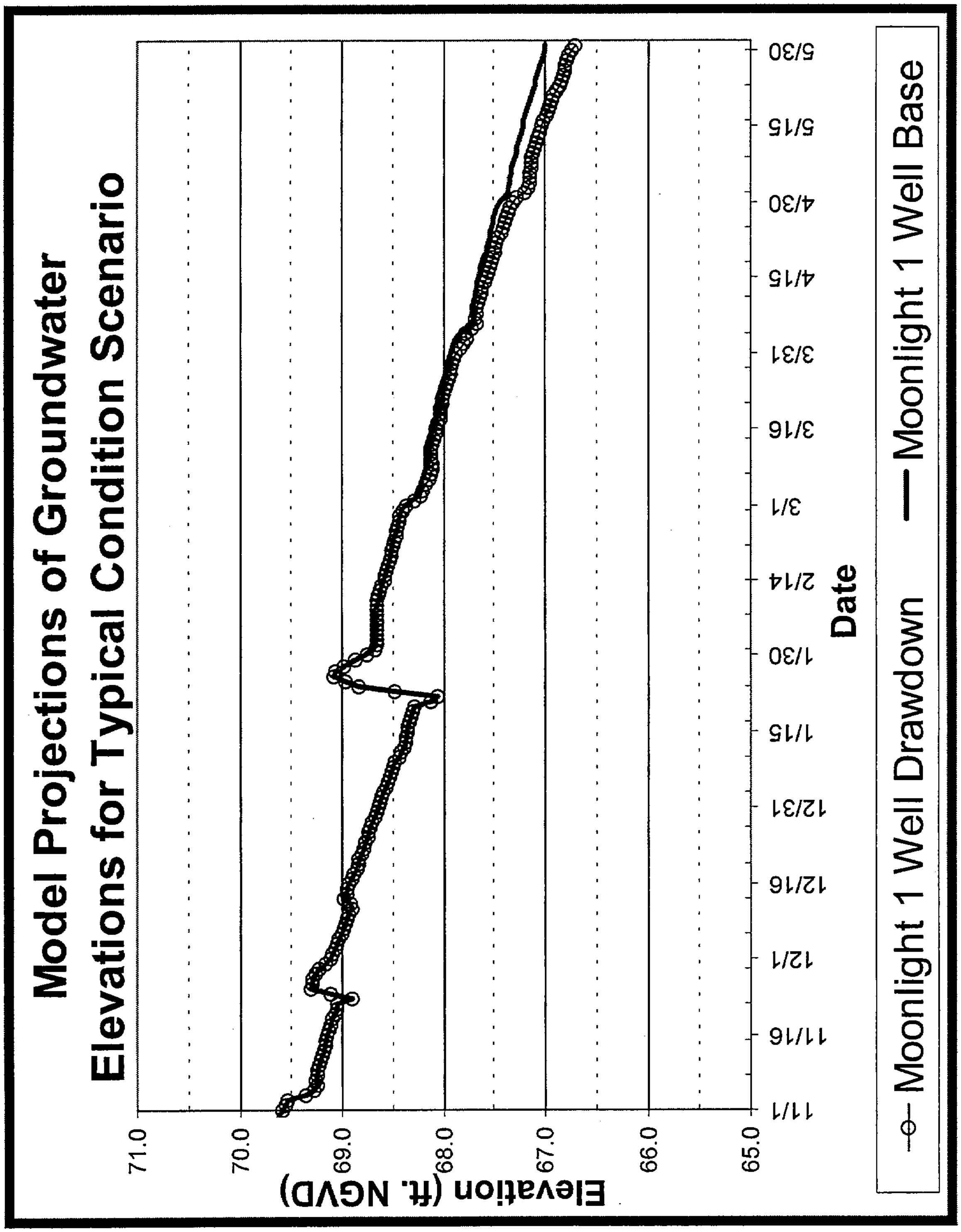

Projected Impact of Drawdown on the Water Table
Typical Rainfall Conditions
Mako Tropicals
Black
Moo
Castelli Farms
Exotic Fish
Exotic Acres
Drawdown [ft]
< 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 1.00
1.00 - 1.25
1.25 - 1.50
1.50 - 2.00
2.00 - 3.00

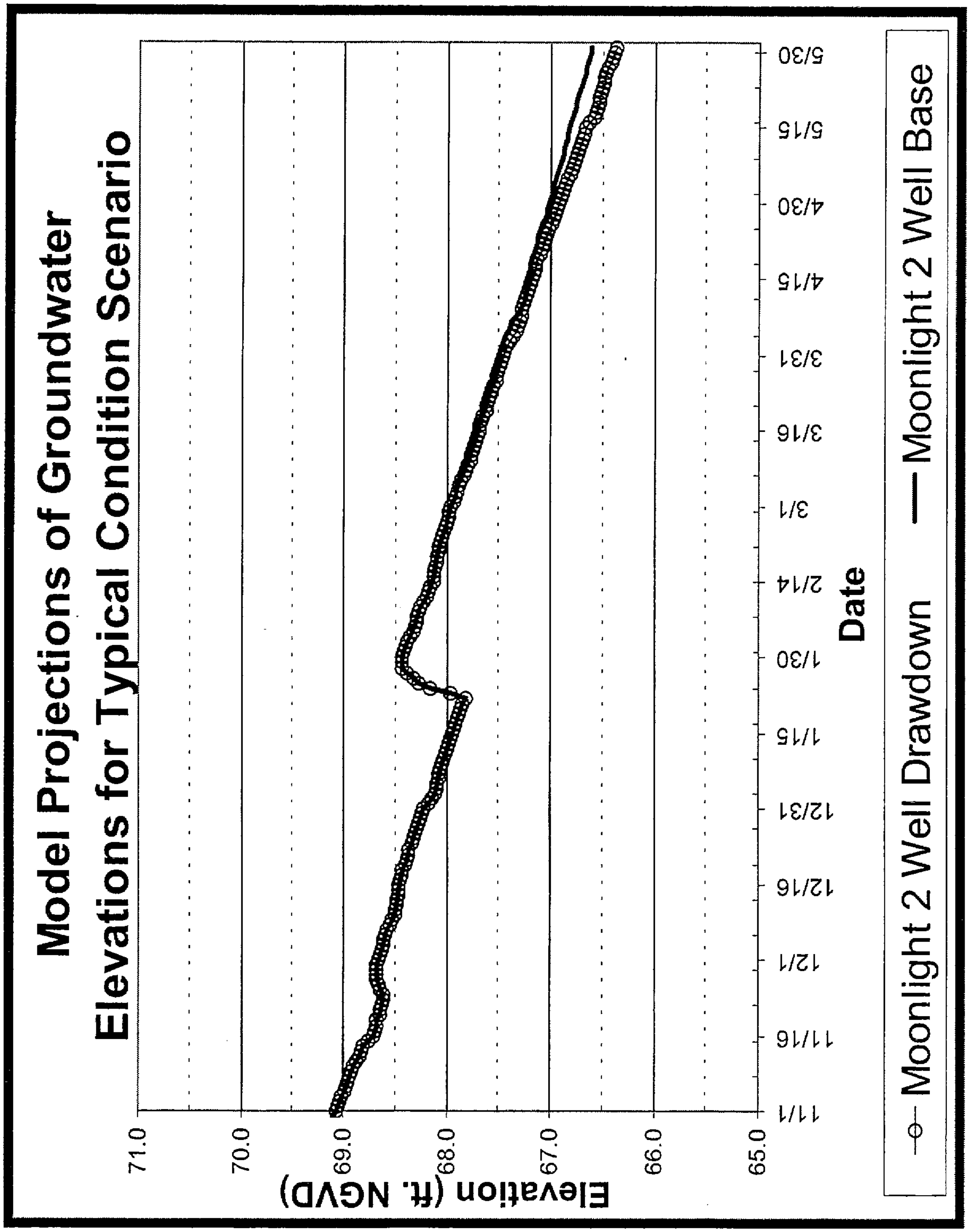

Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
73.0
72.0
71.0
70.0
69.0
68.0
67.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Blackwater Well Drawdown
Blackwater Well Base


Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
72.0
71.0
70.0
69.0
68.0
67.0
66.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Simmons1 Well Drawdown
Simmons1 Well Base

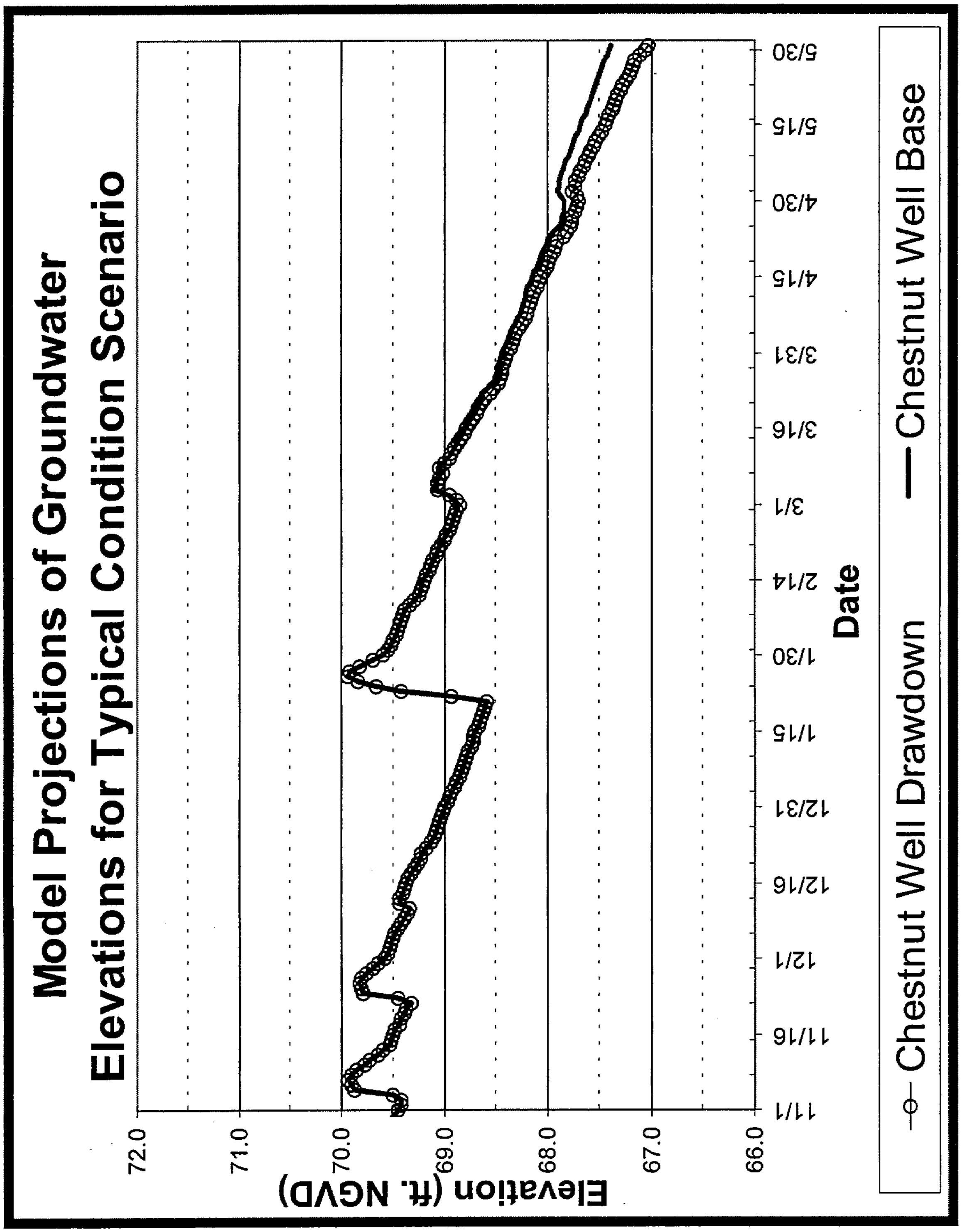

Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
69.0
68.0
67.0
66.0
65.0
64.0
63.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Simmons2 Well Drawdown
Simmons2 Well Base


Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
66.0
65.0
64.0
63.0
62.0
61.0
60.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Beekman Well Drawdown
Beekman Well Base

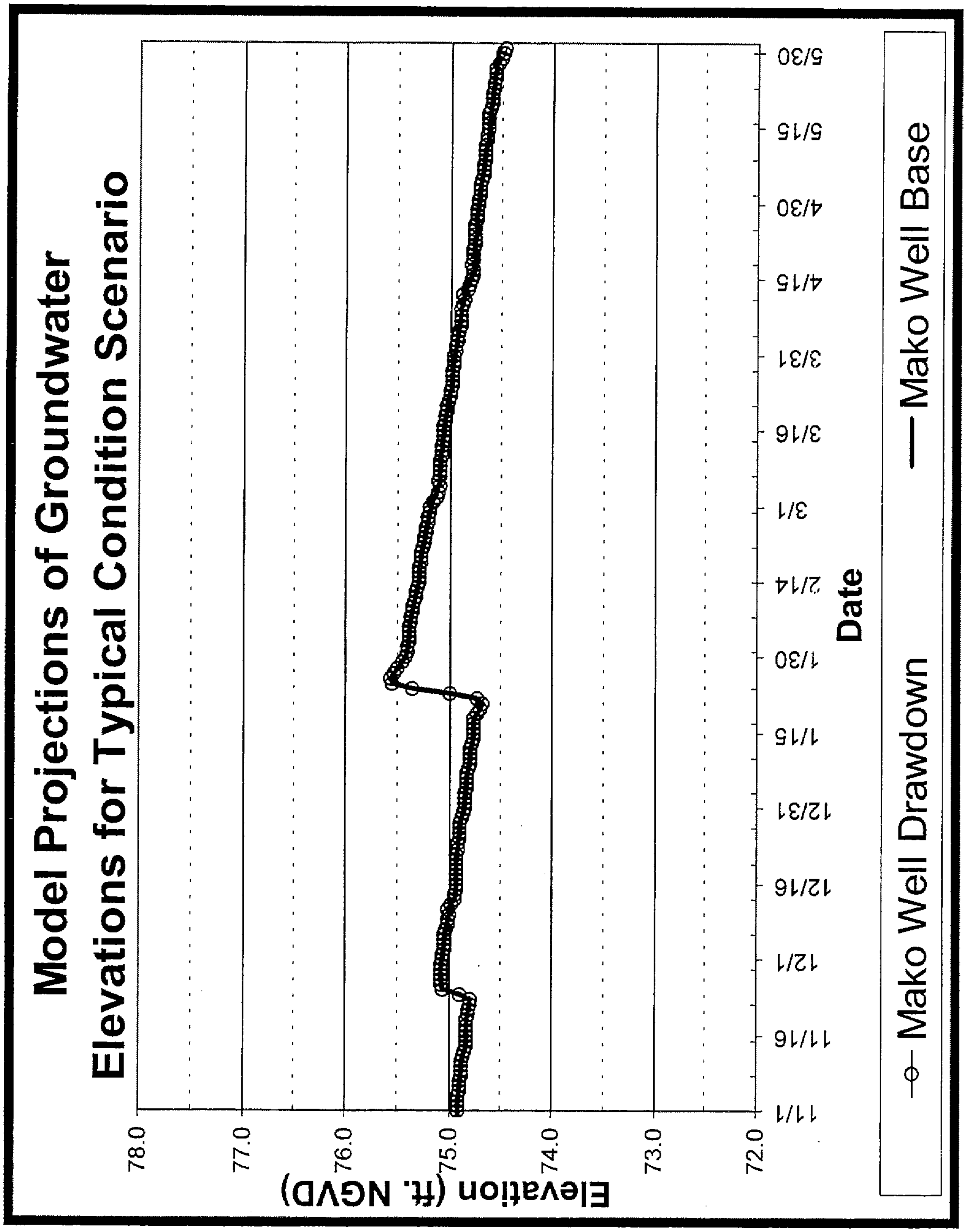

Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
71.0
70.0
69.0
68.0
67.0
66.0
65.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Moonlight 1 Well Drawdown
Moonlight 1 Well Base



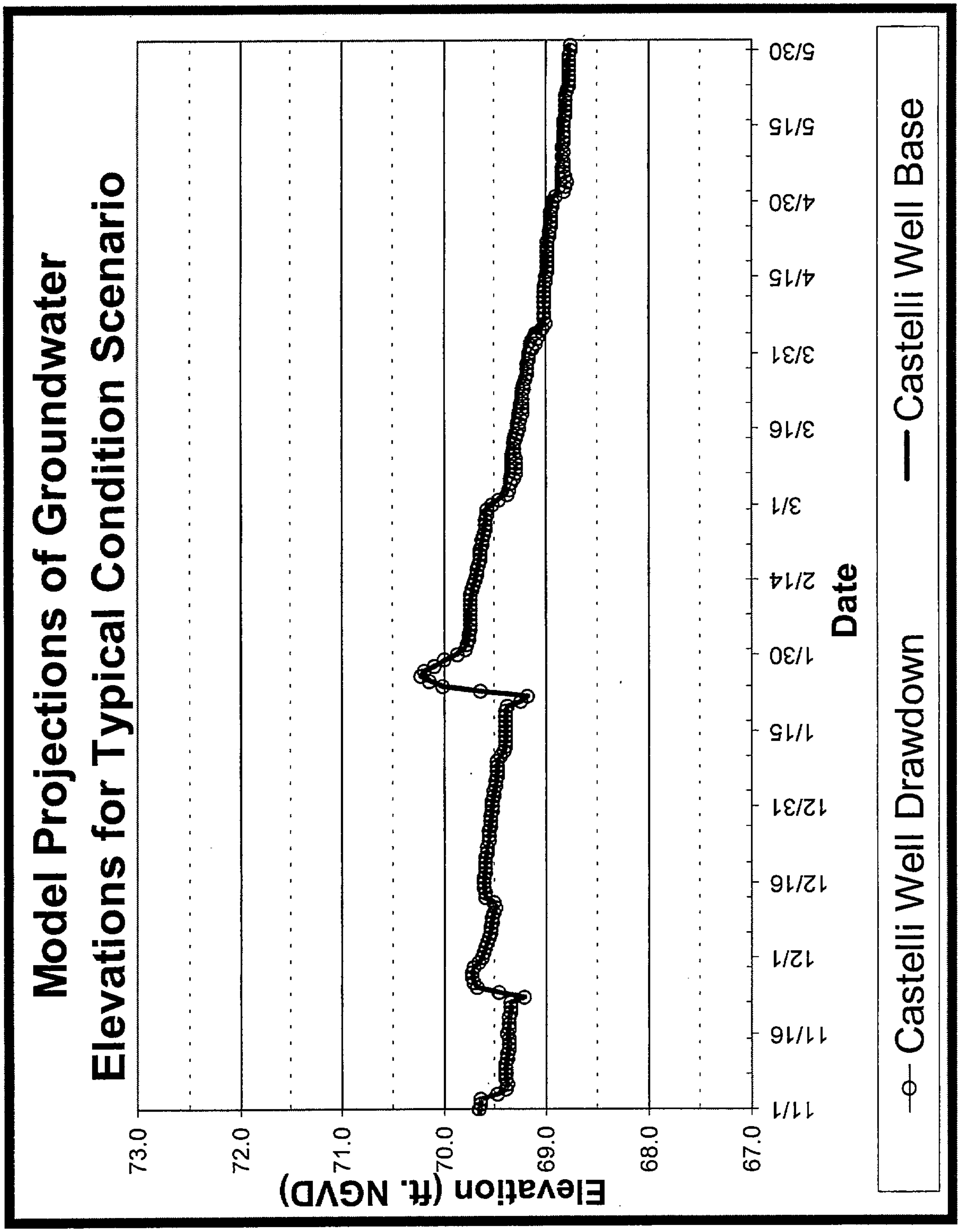
Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
71.0
70.0
69.0
68.0
67.0
66.0
65.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Moonlight 2 Well Drawdown
Moonlight 2 Well Base

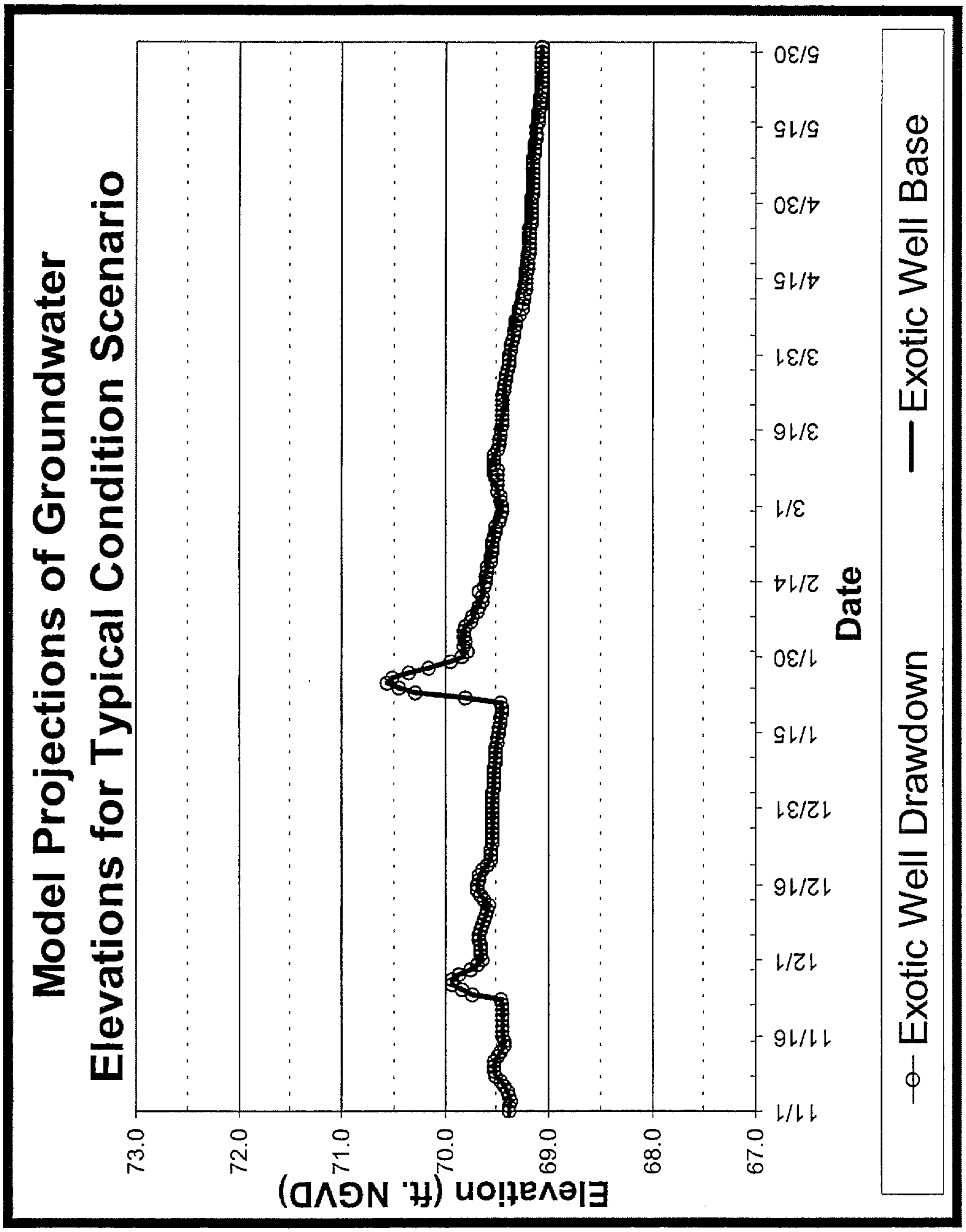


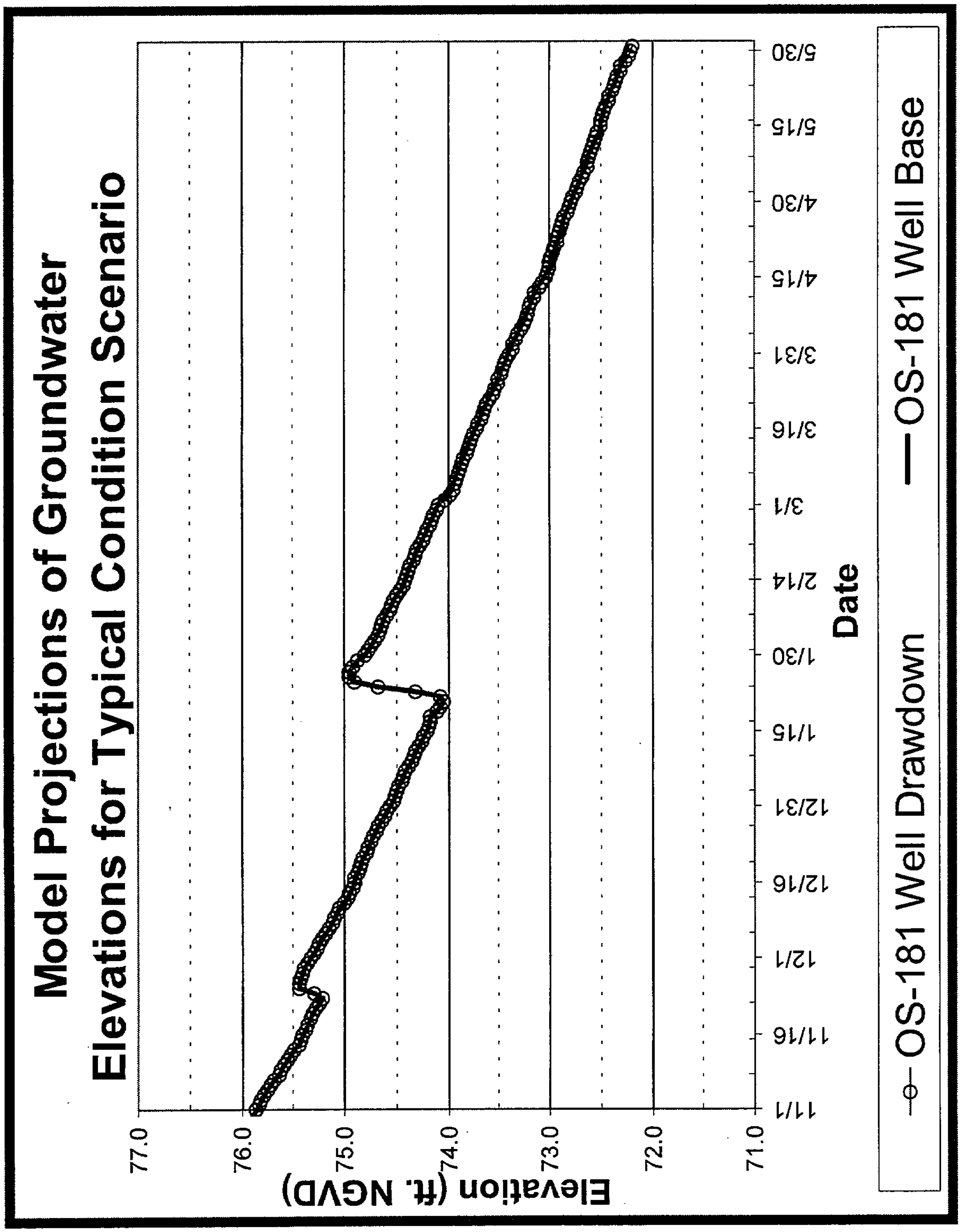
Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
72.0
71.0
70.0
69.0
68.0
67.0
66.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Chestnut Well Drawdown
Chestnut Well Base

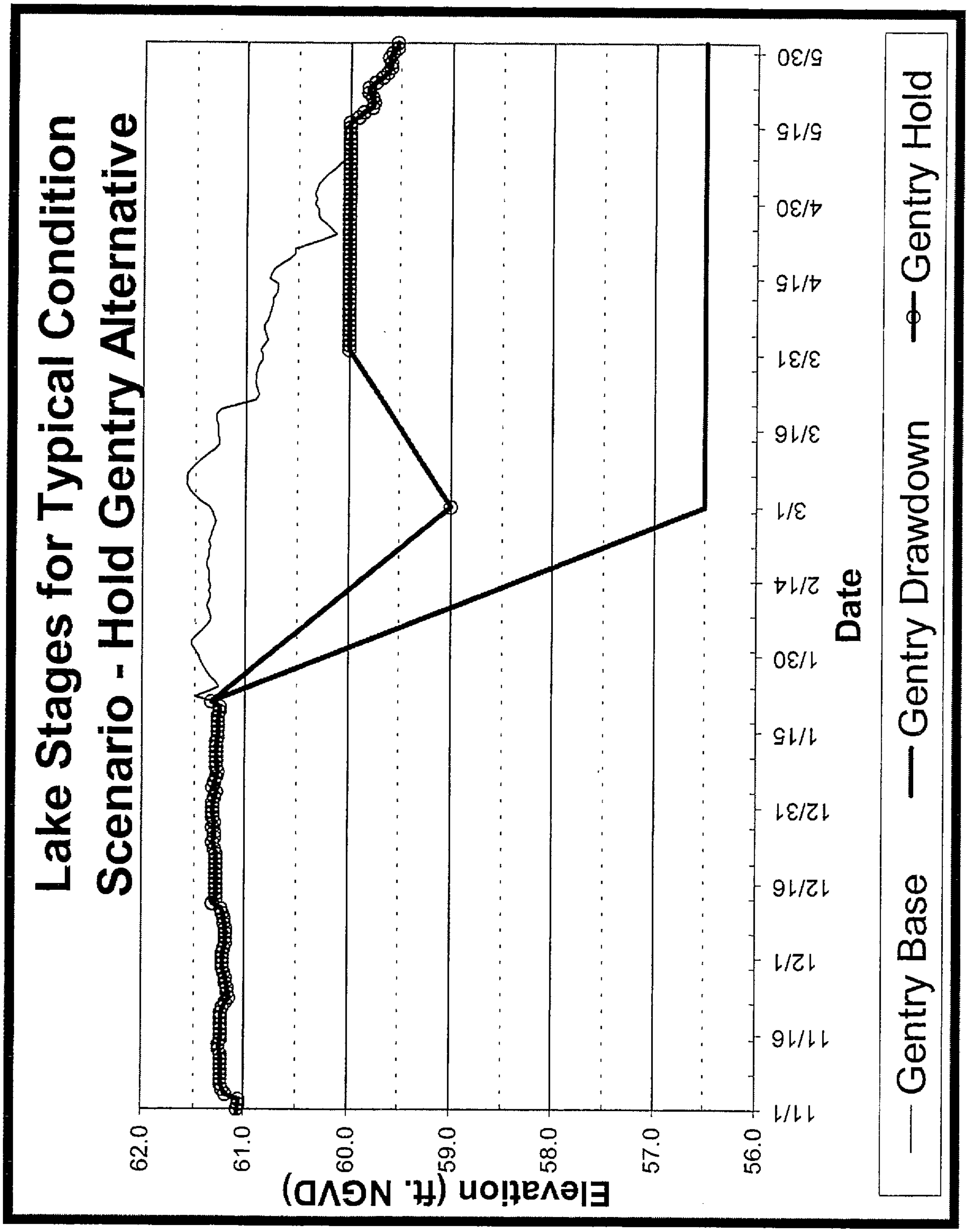


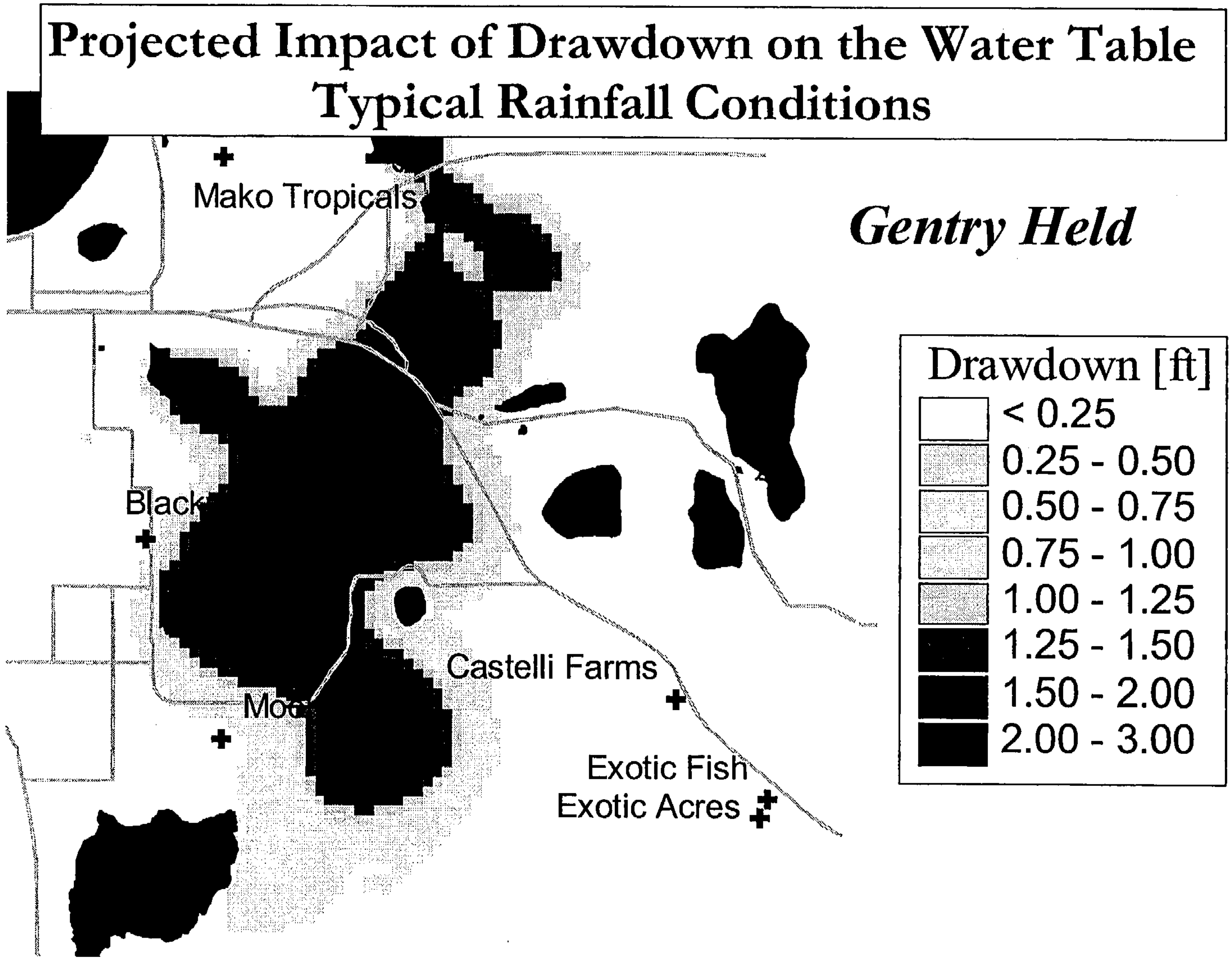
Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
78.0
77.0
76.0
75.0
74.0
73.0
72.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Mako Well Drawdown
Mako Well Base

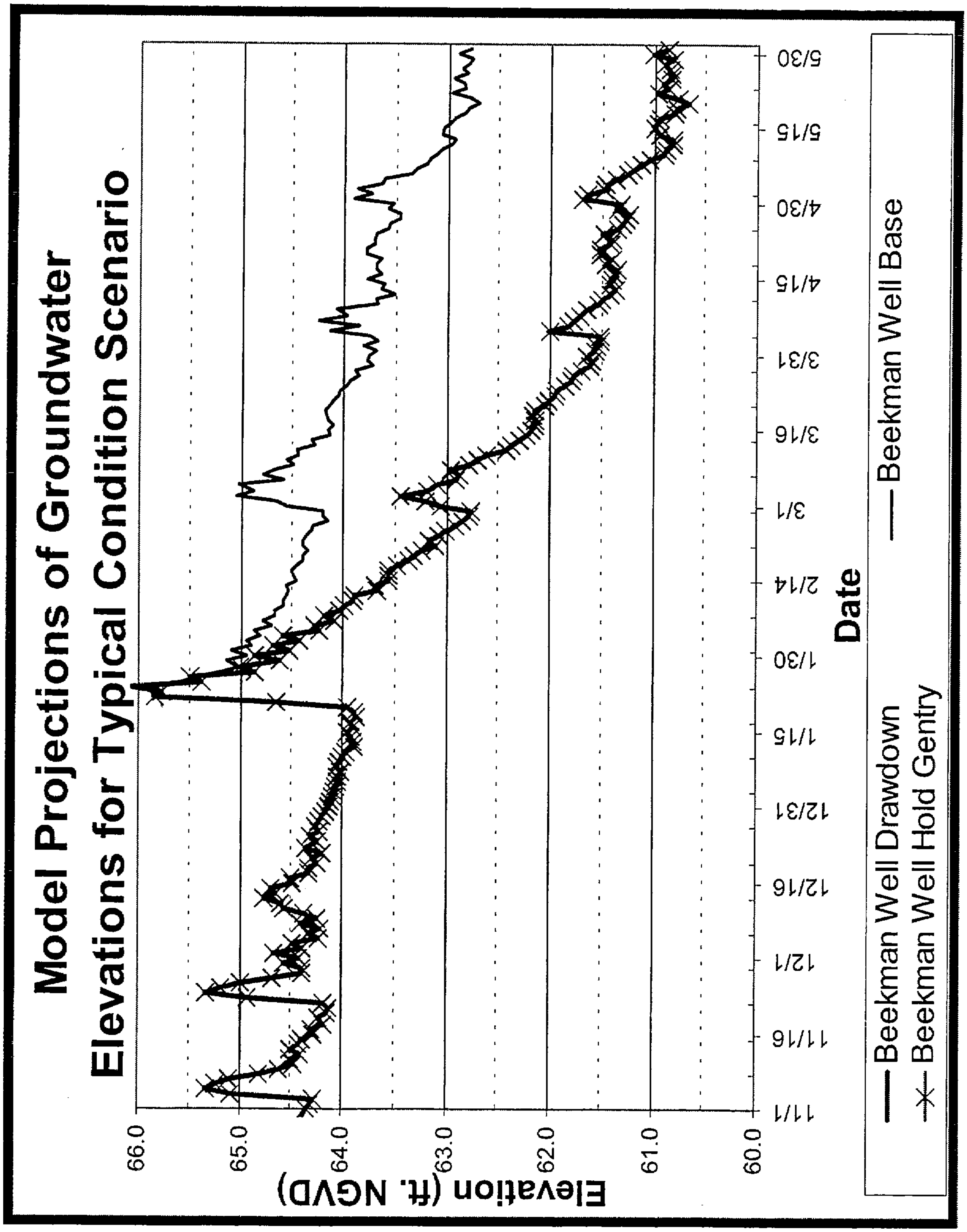

Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
73.0
72.0
71.0
70.0
69.0
68.0
67.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Castelli Well Drawdown
Castelli Well Base


Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
73.0
72.0
71.0
70.0
69.0
68.0
67.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Exotic Well Drawdown
Exotic Well Base

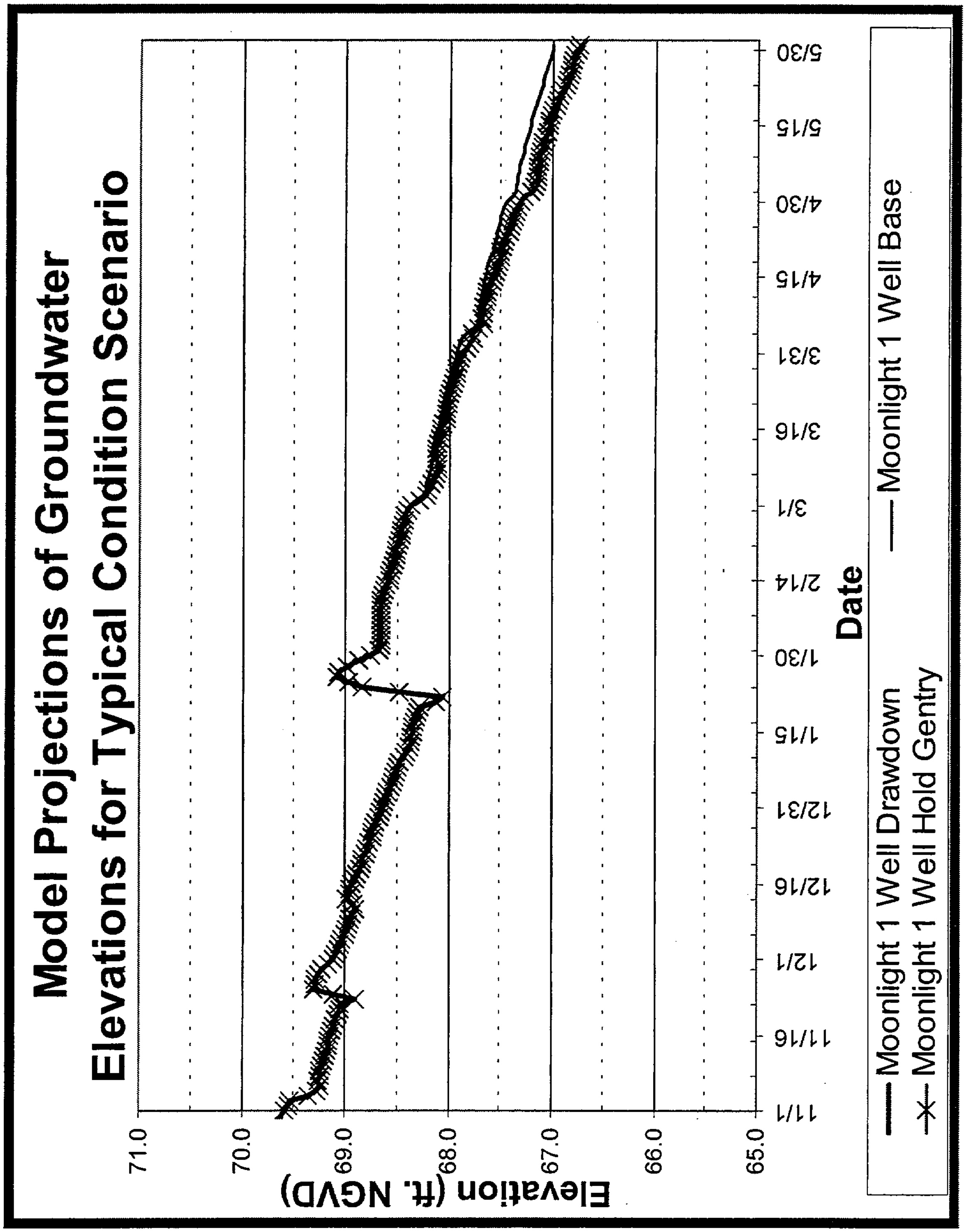

Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
77.0
76.0
75.0
74.0
73.0
72.0
71.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
OS-181 Well Drawdown
OS-181 Well Base

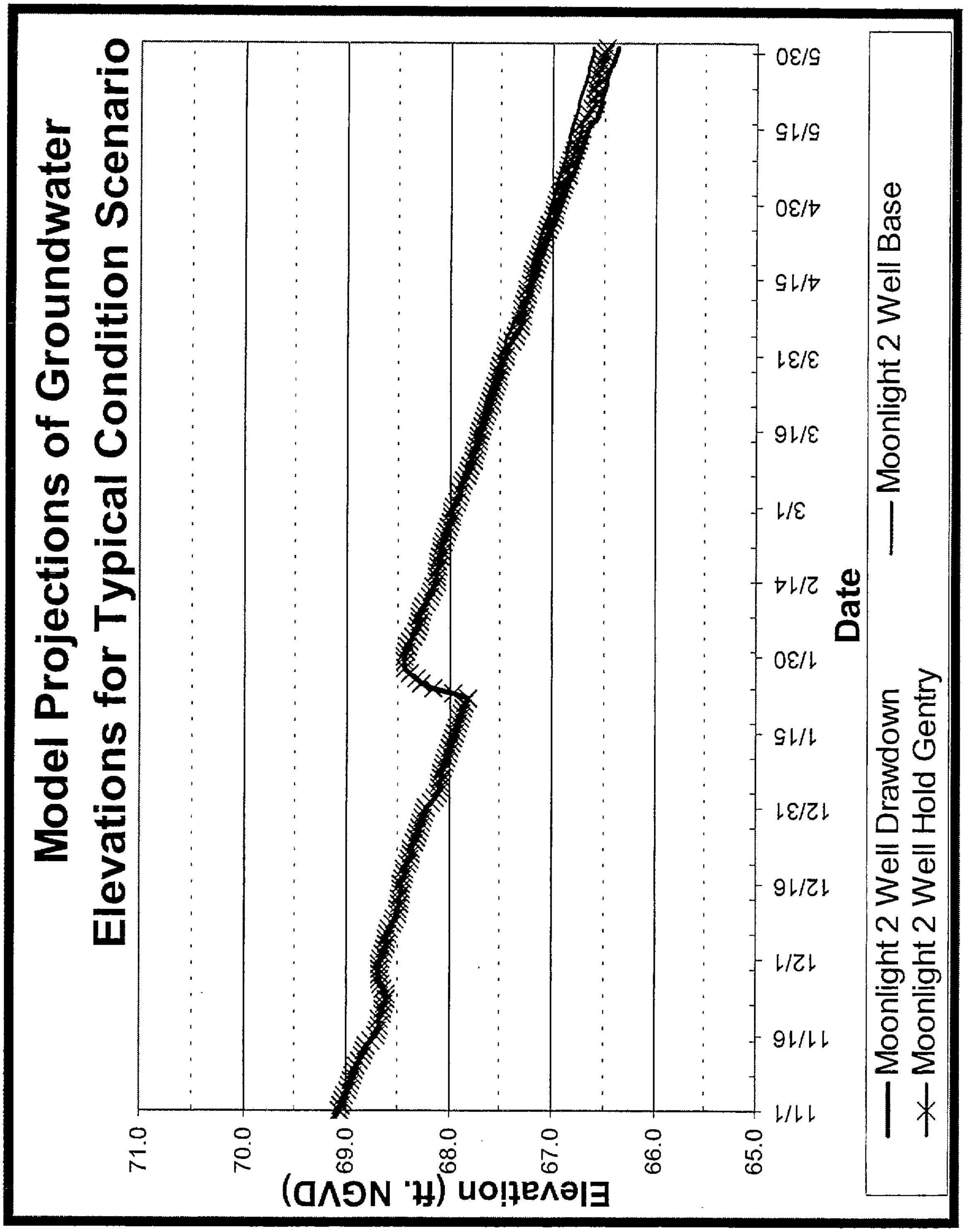

Lake Stages for Typical Condition
Scenario - Hold Gentry Alternative
Elevation (ft. NGVD)
62.0
61.0
60.0
59.0
58.0
57.0
56.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Gentry Base
Gentry Drawdown
Gentry Hold


Projected Impact of Drawdown on the Water Table
Typical Rainfall Conditions
Gentry Held
Mako Tropicals
Black
Moo
Castelli Farms
Exotic Fish
Exotic Acres
Drawdown [ft]
< 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 1.00
1.00 - 1.25
1.25 - 1.50
1.50 - 2.00
2.00 - 3.00



Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
66.0
65.0
64.0
63.0
62.0
61.0
60.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Beekman Well Drawdown
Beekman Well Hold Gentry
Beekman Well Base


Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
71.0
70.0
69.0
68.0
67.0
66.0
65.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Moonlight 1 Well Drawdown
Moonlight 1 Well Hold Gentry
Moonlight 1 Well Base


Model Projections of Groundwater
Elevations for Typical Condition Scenario
Elevation (ft. NGVD)
71.0
70.0
69.0
68.0
67.0
66.0
65.0
11/1
11/16
12/1
12/16
12/31
1/15
1/30
2/14
3/1
3/16
3/31
4/15
4/30
5/15
5/30
Date
Moonlight 2 Well Drawdown
Moonlight 2 Well Base
Moonlight 2 Well Hold Gentry

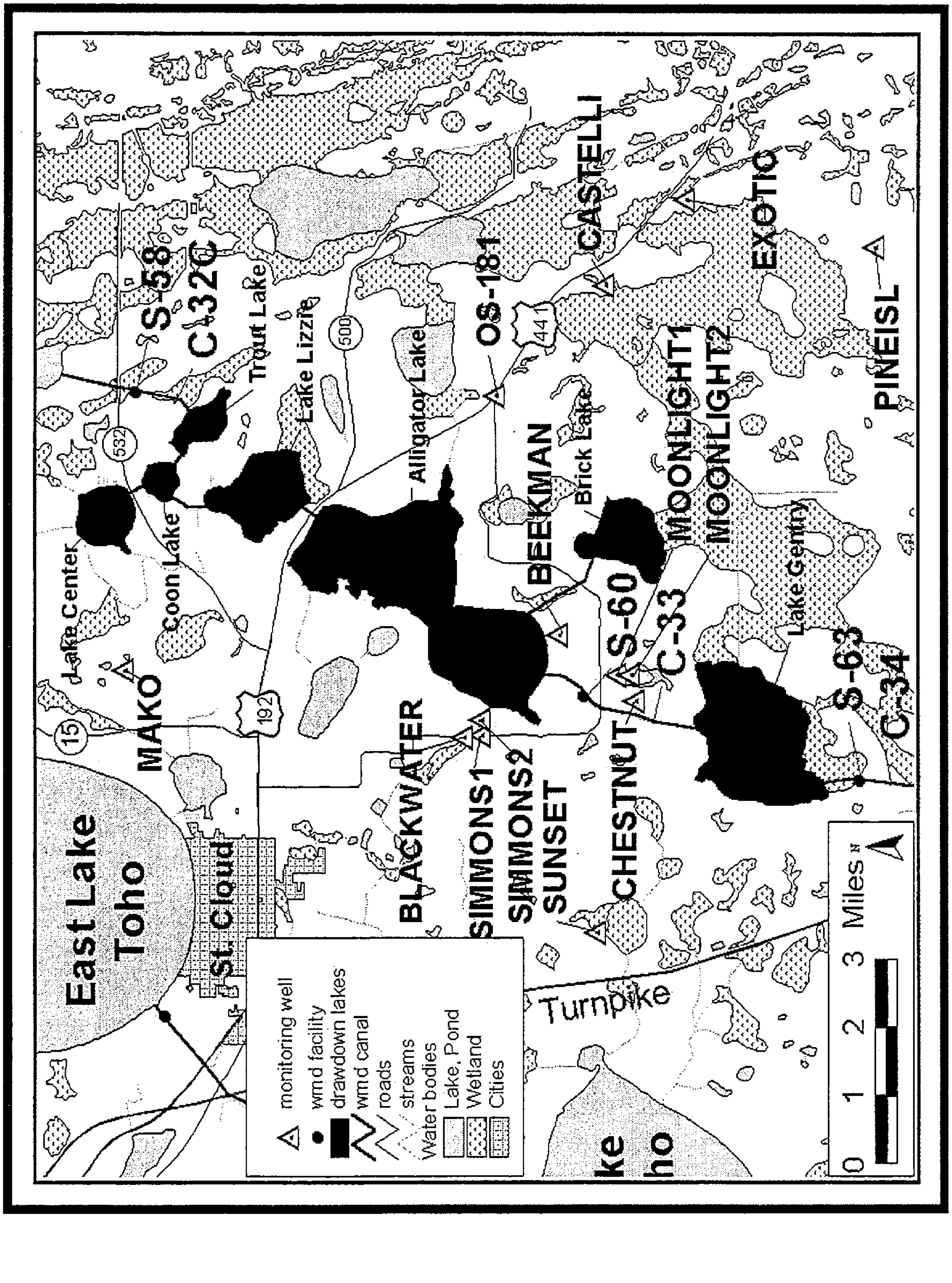
Appendix L. Model Results - Severe Drought Condition Scenario

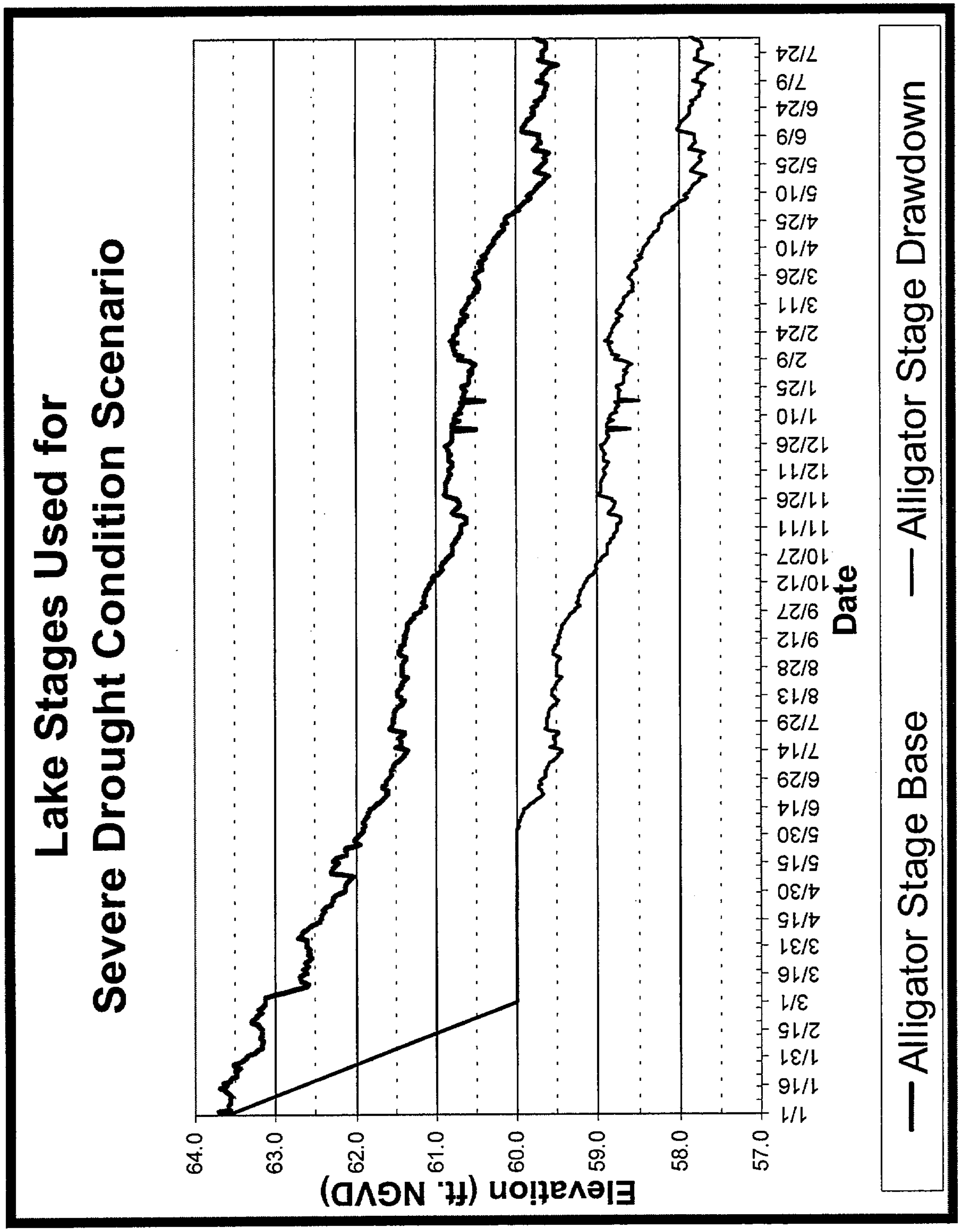
Model Results - Severe Drought Condition Scenario

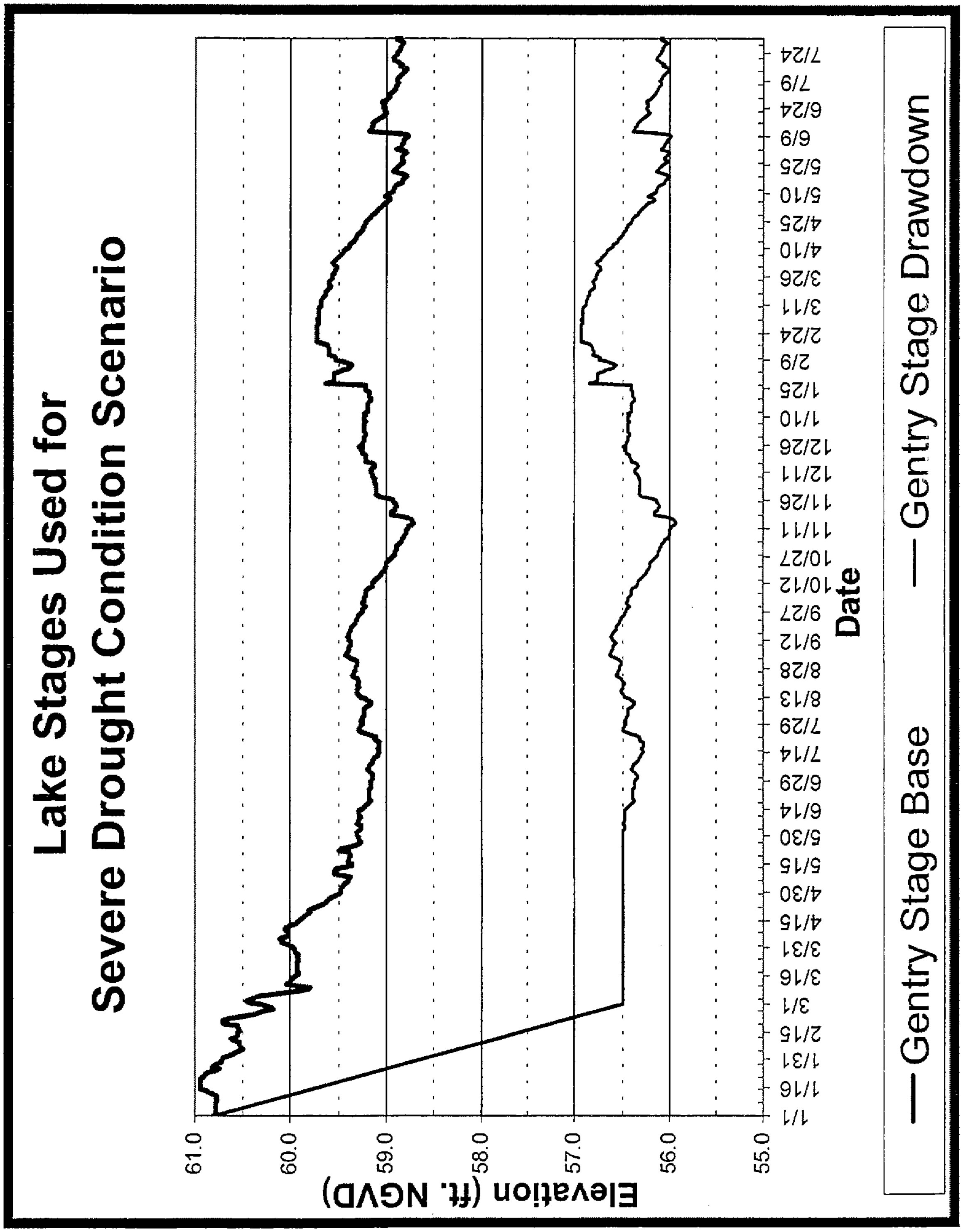
The calibrated model was used to predict the impact to the water table aquifer. The Severe Drought Condition Scenario utilizes the weather conditions experienced in 1980-81 (rainfall is based on the Pine Island monitoring site). The following pages show the lake stage and rainfall used for this modeling scenario. Following that is a series of graphs showing predicted well stage, with and without a drawdown. The difference between the two lines is the predicted impact due to the drawdown. Also included are graphs showing predicted well stage for the Hold Gentry Alternative at the wells between Alligator Lake and Lake Gentry.

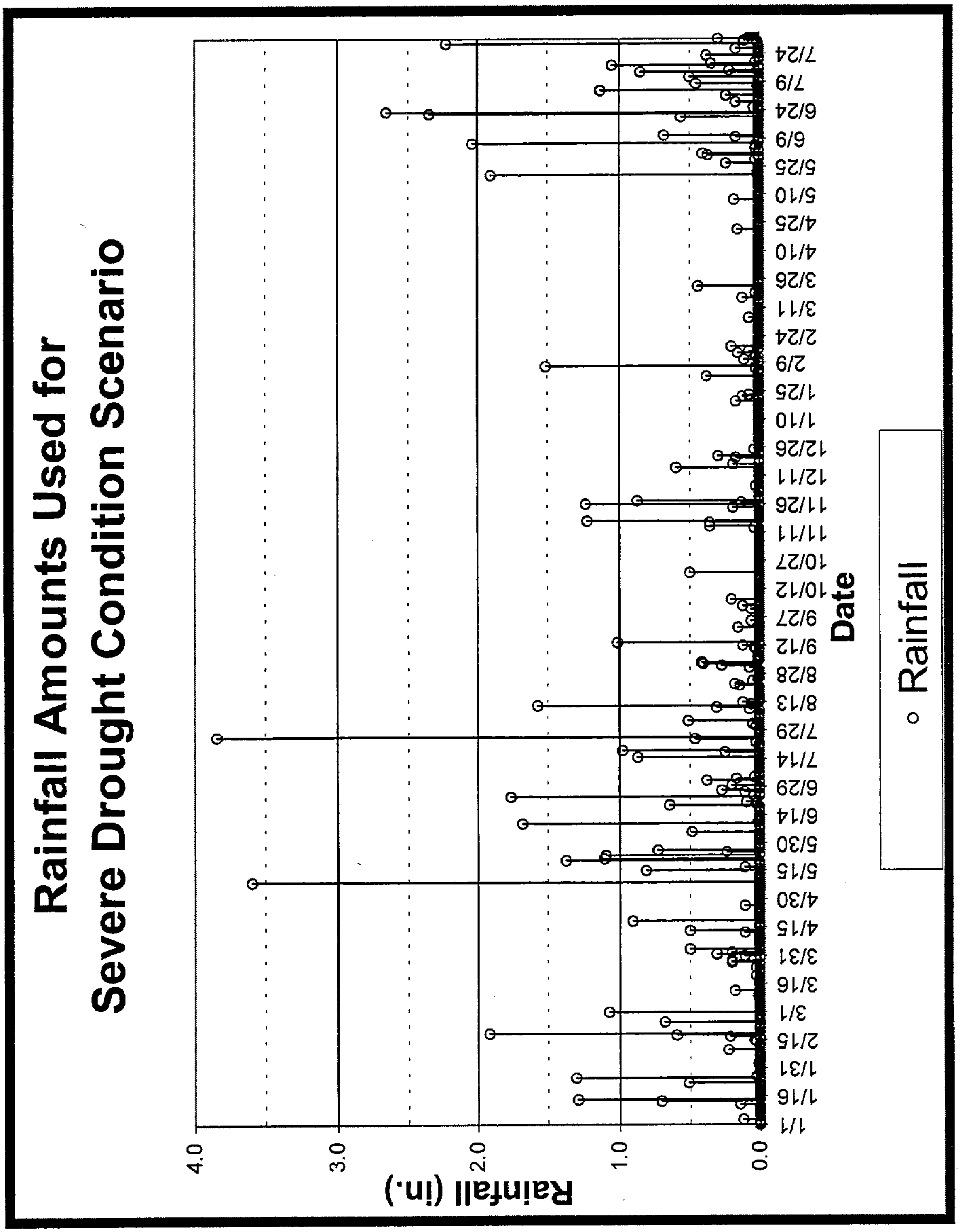
The appendix contains the following:

- Monitoring well location map
- Graphs of lake stages used for scenario
- Graph of rainfall used for scenario
- Map showing area of impact
- Graphs showing predicted water levels in monitoring wells
- Graphs of lake stages used for hold Gentry alternative
- Graphs showing predicted water levels in monitoring wells for hold Gentry alternative


East Lake Toho
St. Cloud
MAKO
Lake Center
Coon Lake
S-58
C-32C
Trout Lake
Lake Lizzie
Alligator Lake
OS-181
CASTELLI
BEEKMAN
Brick Lake
MOONLIGHT1
MOONLIGHT2
EXOTIC
PINEISL
BLACKWATER
SIMMONS1
SIMMONS2
SUNSET
CHESTNUT
S-60
C-33
S-63
C-34
Lake Gentry
Turnpike
15
192
532
500
441
monitoring well
wmd facility
drawdown lakes
wmd canal
roads
streams
Water bodies
Lake, Pond
Wetland
Cities
0 1 2 3 Miles
N

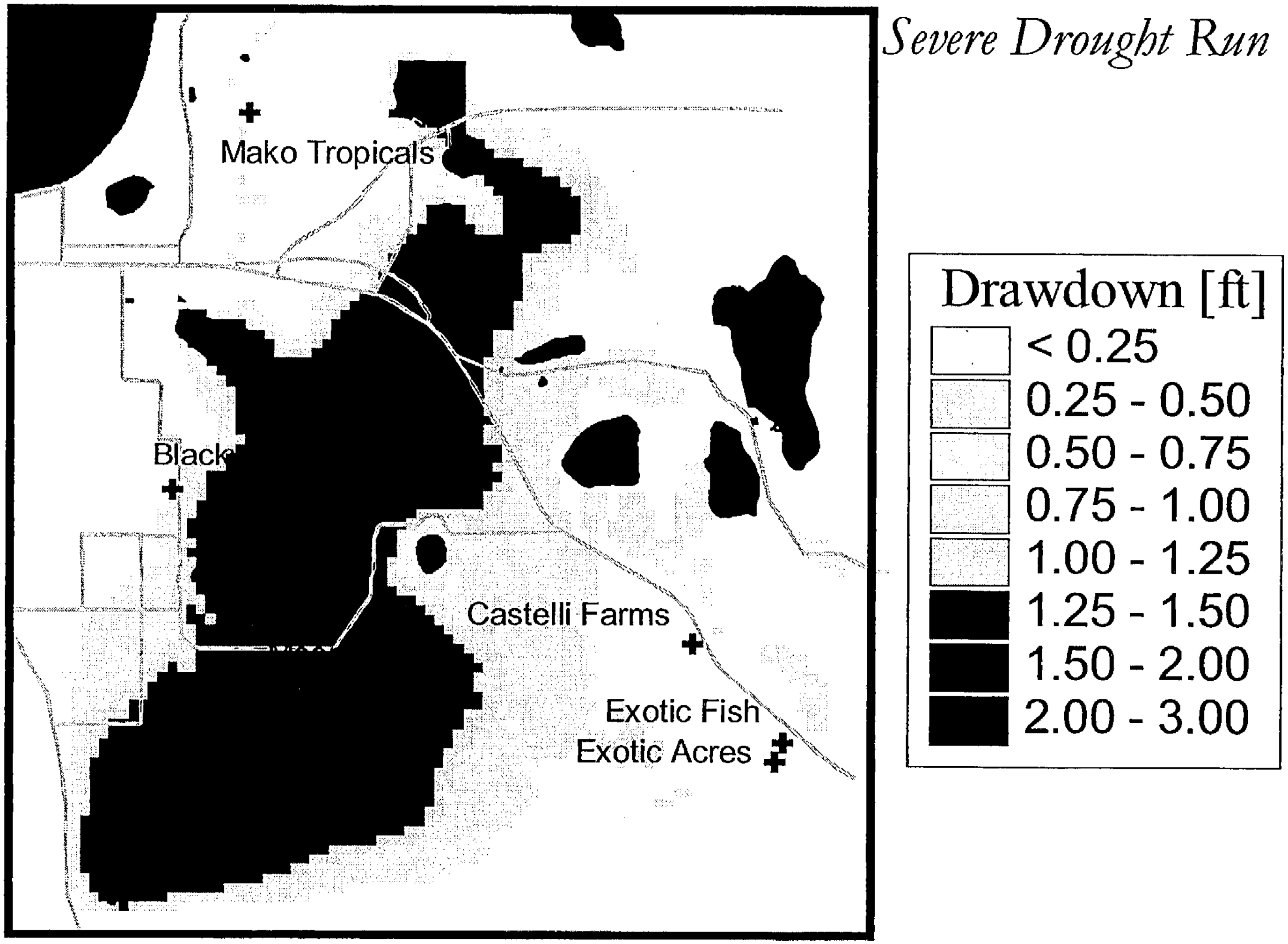

Lake Stages Used for
Severe Drought Condition Scenario
Elevation (ft. NGVD)
64.0
63.0
62.0
61.0
60.0
59.0
58.0
57.0
1/1
1/16
1/31
2/15
3/1
3/16
3/31
4/15
4/30
5/15
5/30
6/14
6/29
7/14
7/29
8/13
8/28
9/12
9/27
10/12
10/27
11/11
11/26
12/11
12/26
1/10
1/25
2/9
2/24
3/11
3/26
4/10
4/25
5/10
5/25
6/9
6/24
7/9
7/24
Date
Alligator Stage Base
Alligator Stage Drawdown

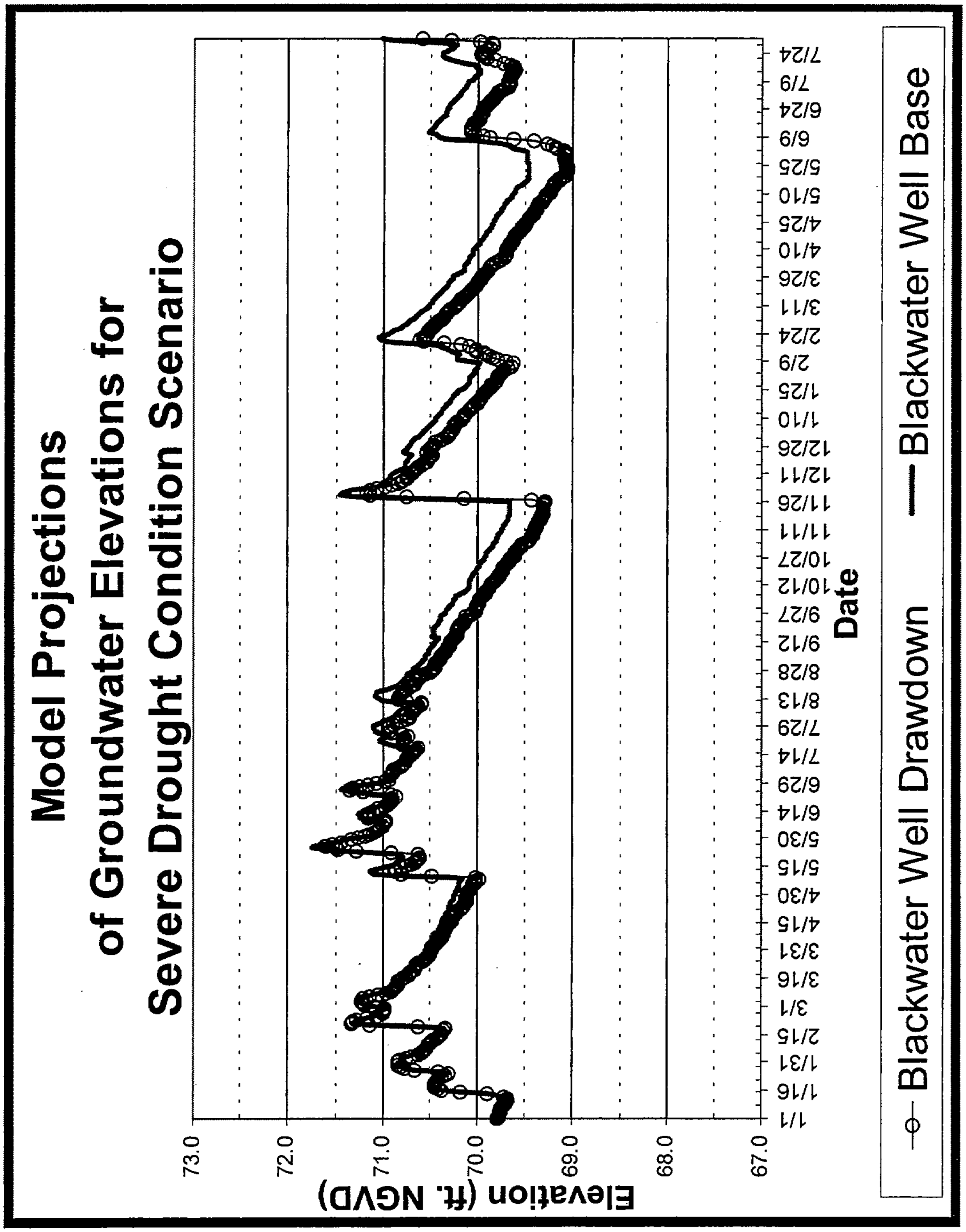

Lake Stages Used for
Severe Drought Condition Scenario
Elevation (ft. NGVD)
61.0
60.0
59.0
58.0
57.0
56.0
55.0
1/1
1/16
1/31
2/15
3/1
3/16
3/31
4/15
4/30
5/15
5/30
6/14
6/29
7/14
7/29
8/13
8/28
9/12
9/27
10/12
10/27
11/11
11/26
12/11
12/26
1/10
1/25
2/9
2/24
3/11
3/26
4/10
4/25
5/10
5/25
6/9
6/24
7/9
7/24
Date
Gentry Stage Base
Gentry Stage Drawdown


Rainfall Amounts Used for
Severe Drought Condition Scenario
Rainfall (in.)
0.0
1.0
2.0
3.0
4.0
Date
1/1
1/16
1/31
2/15
3/1
3/16
3/31
4/15
4/30
5/15
5/30
6/14
6/29
7/14
7/29
8/13
8/28
9/12
9/27
10/12
10/27
11/11
11/26
12/11
12/26
1/10
1/25
2/9
2/24
3/11
3/26
4/10
4/25
5/10
5/25
6/9
6/24
7/9
7/24
Rainfall

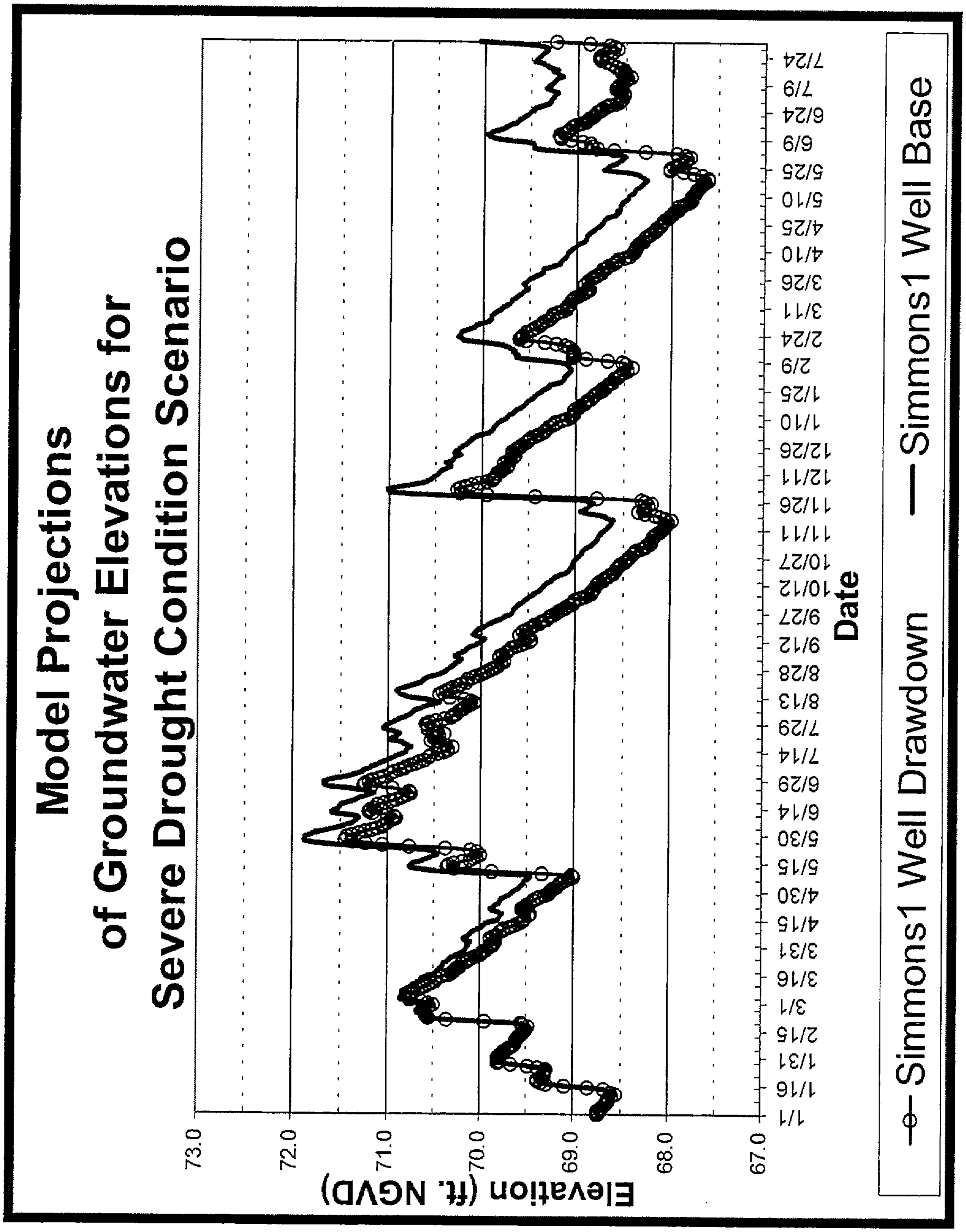
Projected Impact of Lake Drawdown on the Water Table Aquifer

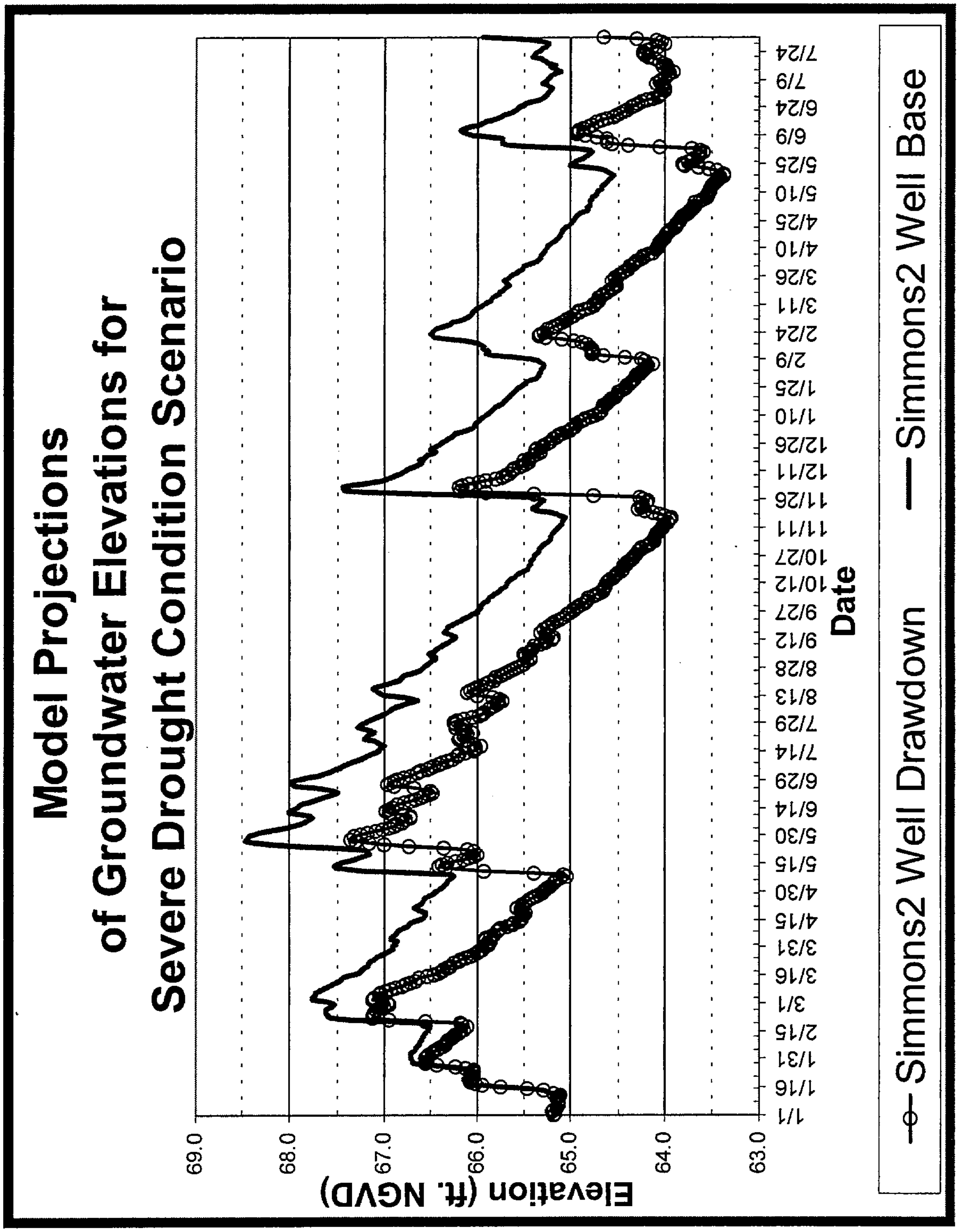
Severe Drought Run





Model Projections
of Groundwater Elevations for
Severe Drought Condition Scenario
Elevation (ft. NGVD)
73.0
72.0
71.0
70.0
69.0
68.0
67.0
1/1
1/16
1/31
2/15
3/1
3/16
3/31
4/15
4/30
5/15
5/30
6/14
6/29
7/14
7/29
8/13
8/28
9/12
9/27
10/12
10/27
11/11
11/26
12/11
12/26
1/10
1/25
2/9
2/24
3/11
3/26
4/10
4/25
5/10
5/25
6/9
6/24
7/9
7/24
Date
Blackwater Well Drawdown
Blackwater Well Base


Model Projections
of Groundwater Elevations for
Severe Drought Condition Scenario
Elevation (ft. NGVD)
73.0
72.0
71.0
70.0
69.0
68.0
67.0
1/1
1/16
1/31
2/15
3/1
3/16
3/31
4/15
4/30
5/15
5/30
6/14
6/29
7/14
7/29
8/13
8/28
9/12
9/27
10/12
10/27
11/11
11/26
12/11
12/26
1/10
1/25
2/9
2/24
3/11
3/26
4/10
4/25
5/10
5/25
6/9
6/24
7/9
7/24
Date
Simmons1 Well Drawdown
Simmons1 Well Base


Model Projections
of Groundwater Elevations for
Severe Drought Condition Scenario
Elevation (ft. NGVD)
69.0
68.0
67.0
66.0
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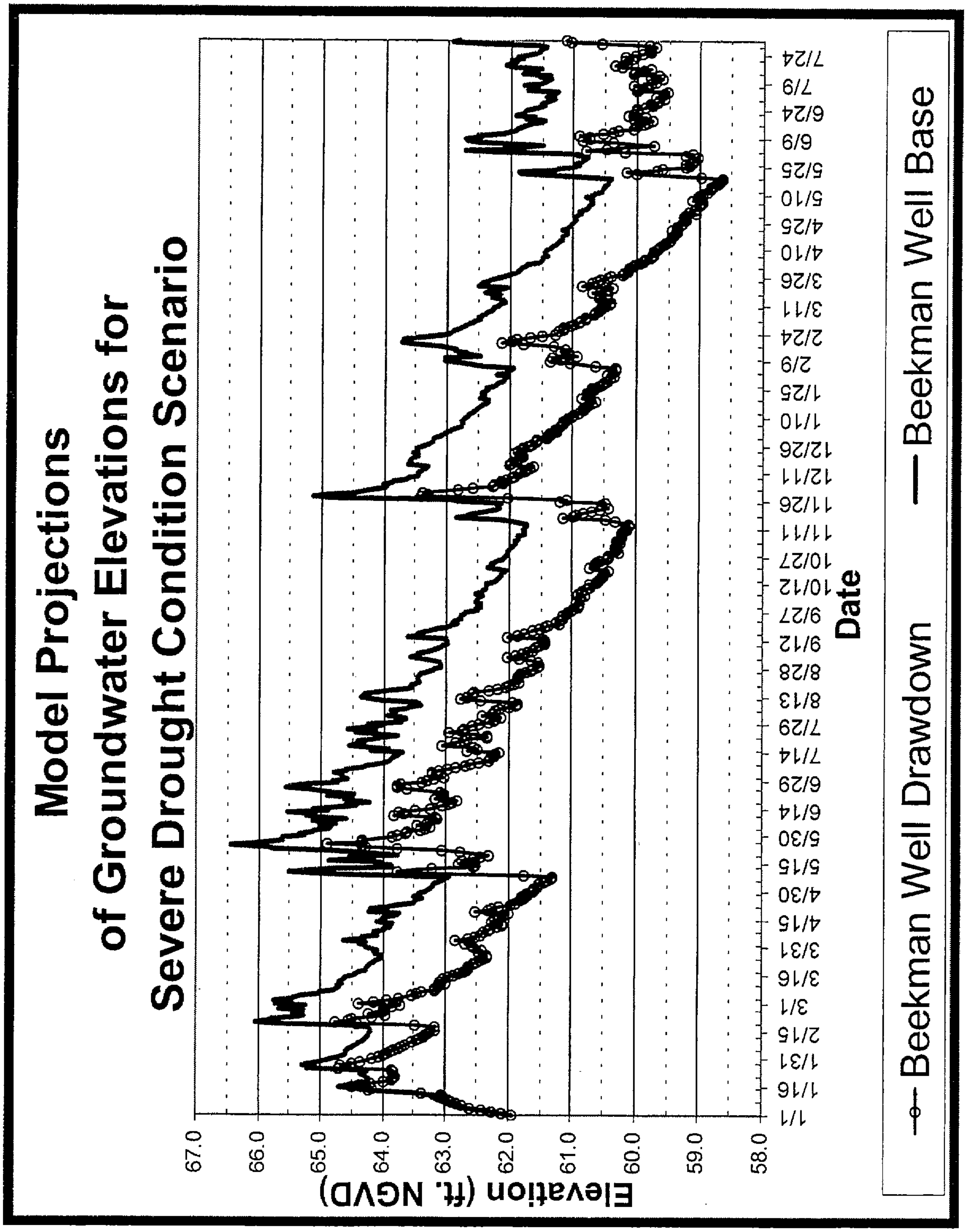
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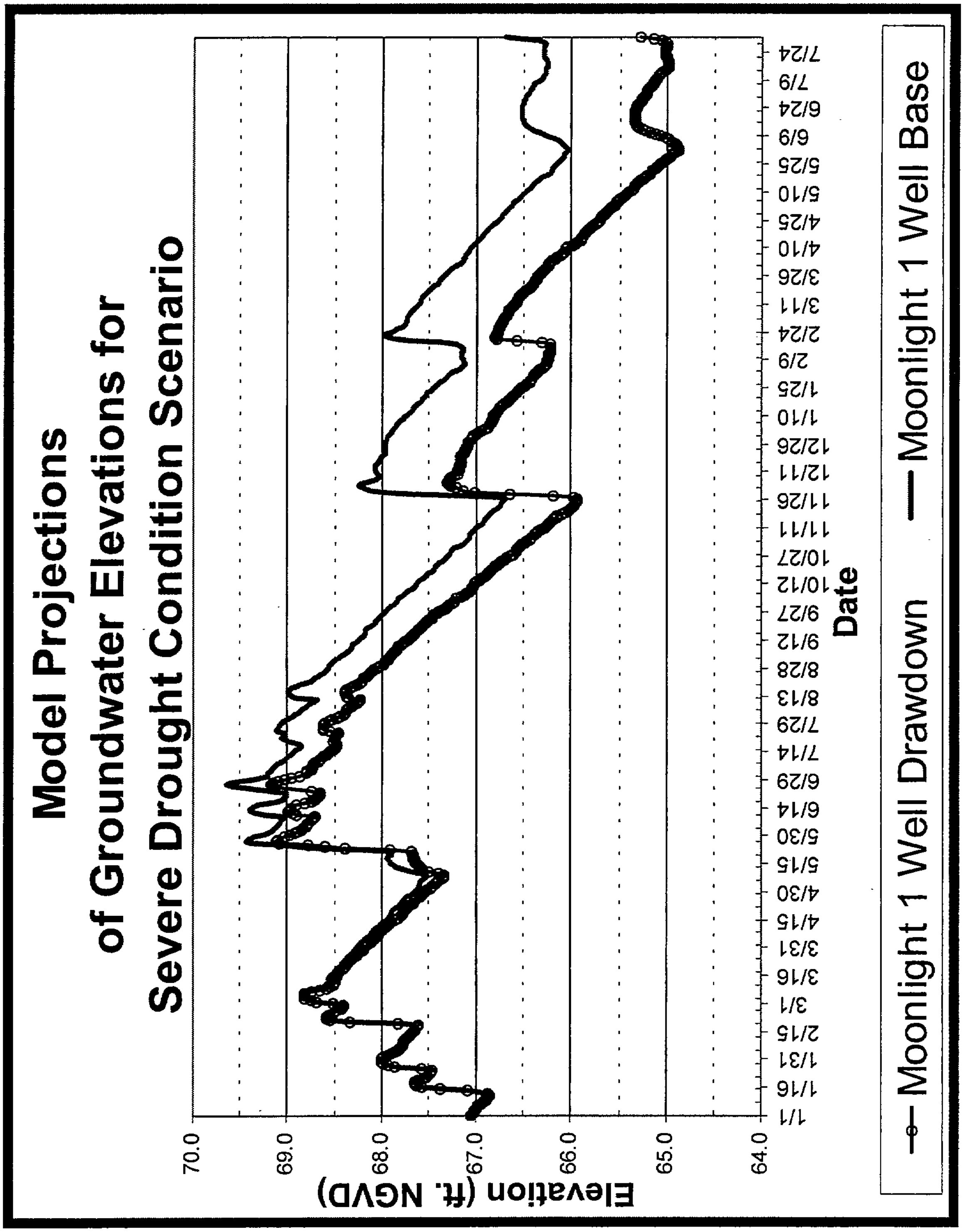
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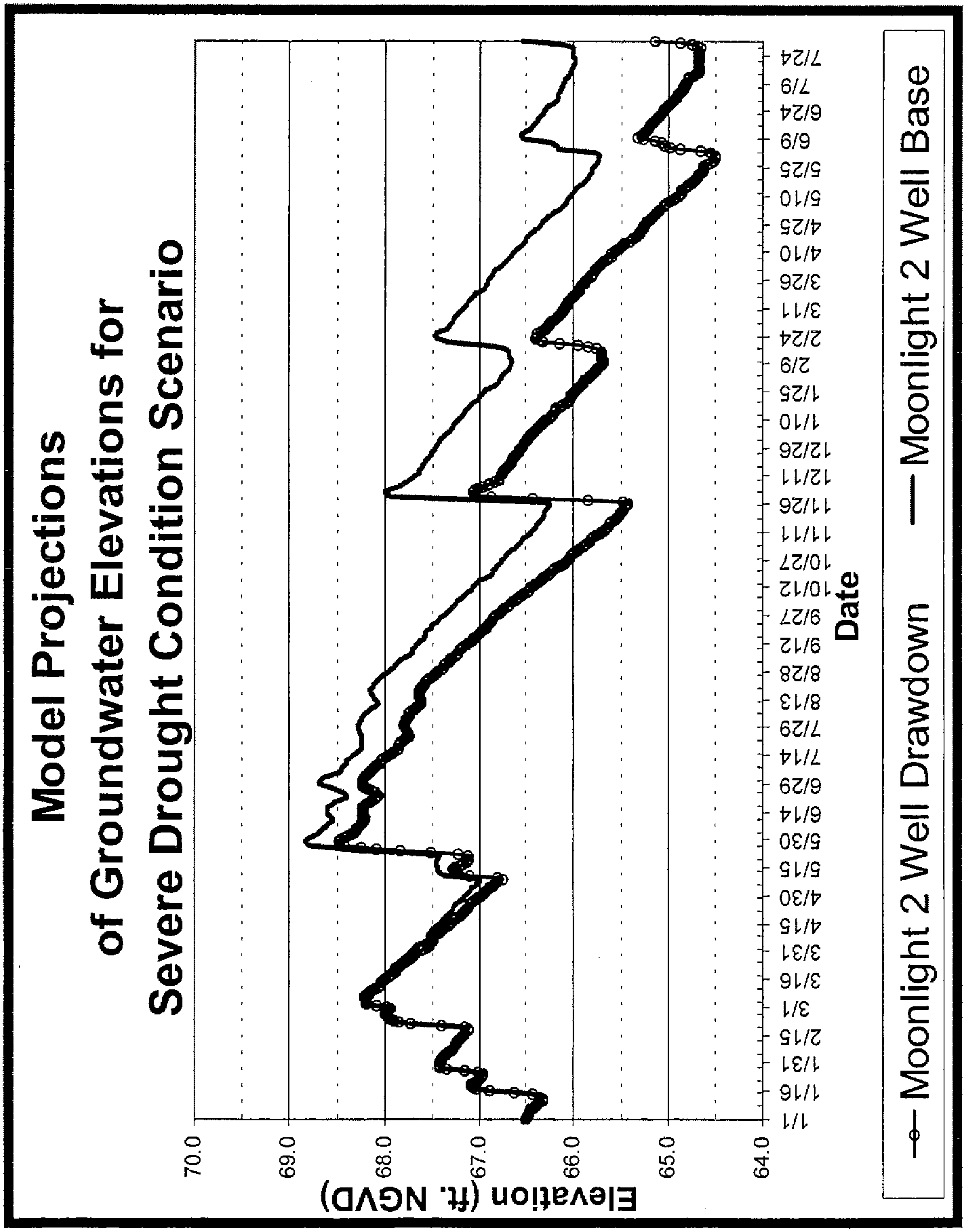
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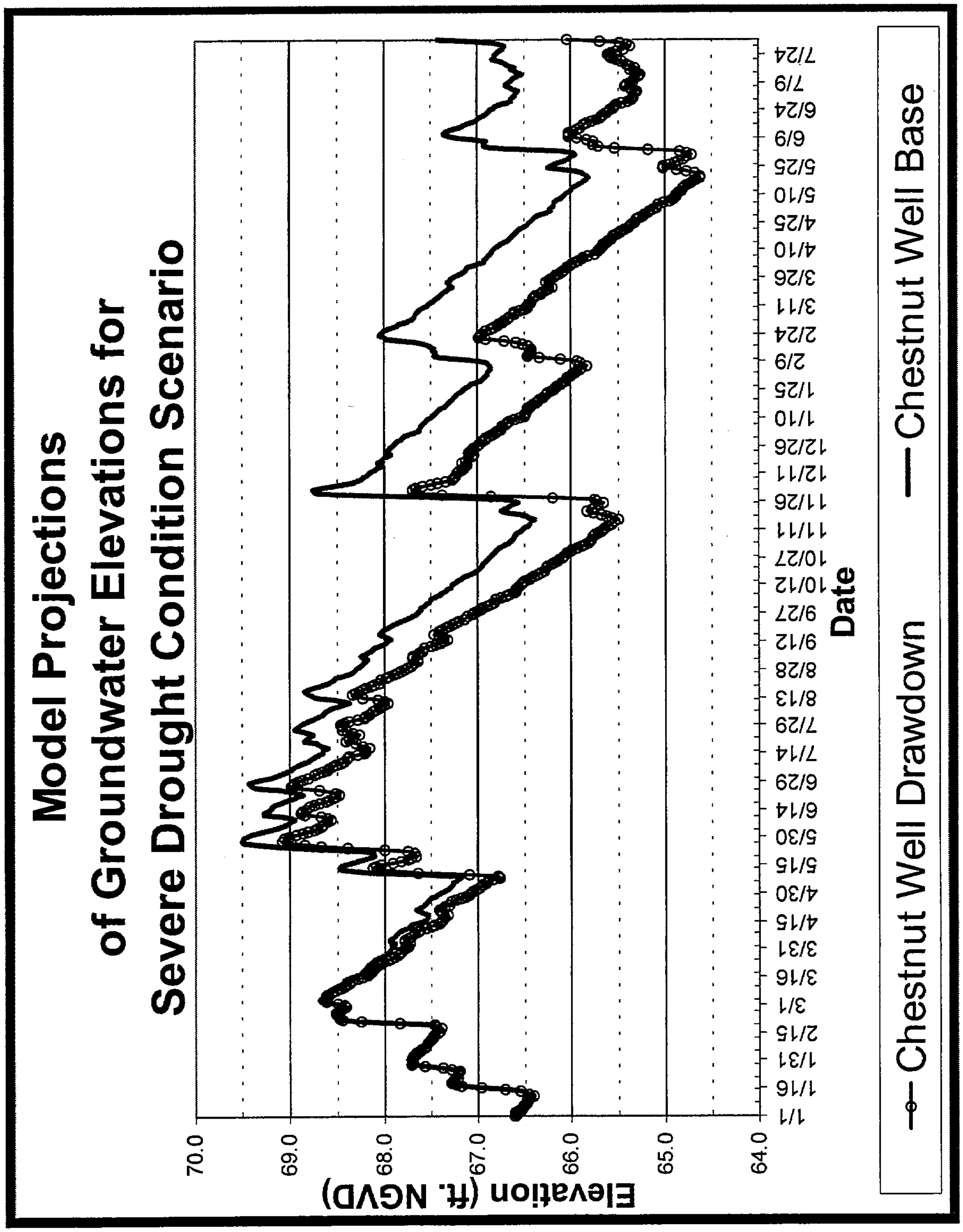
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Date
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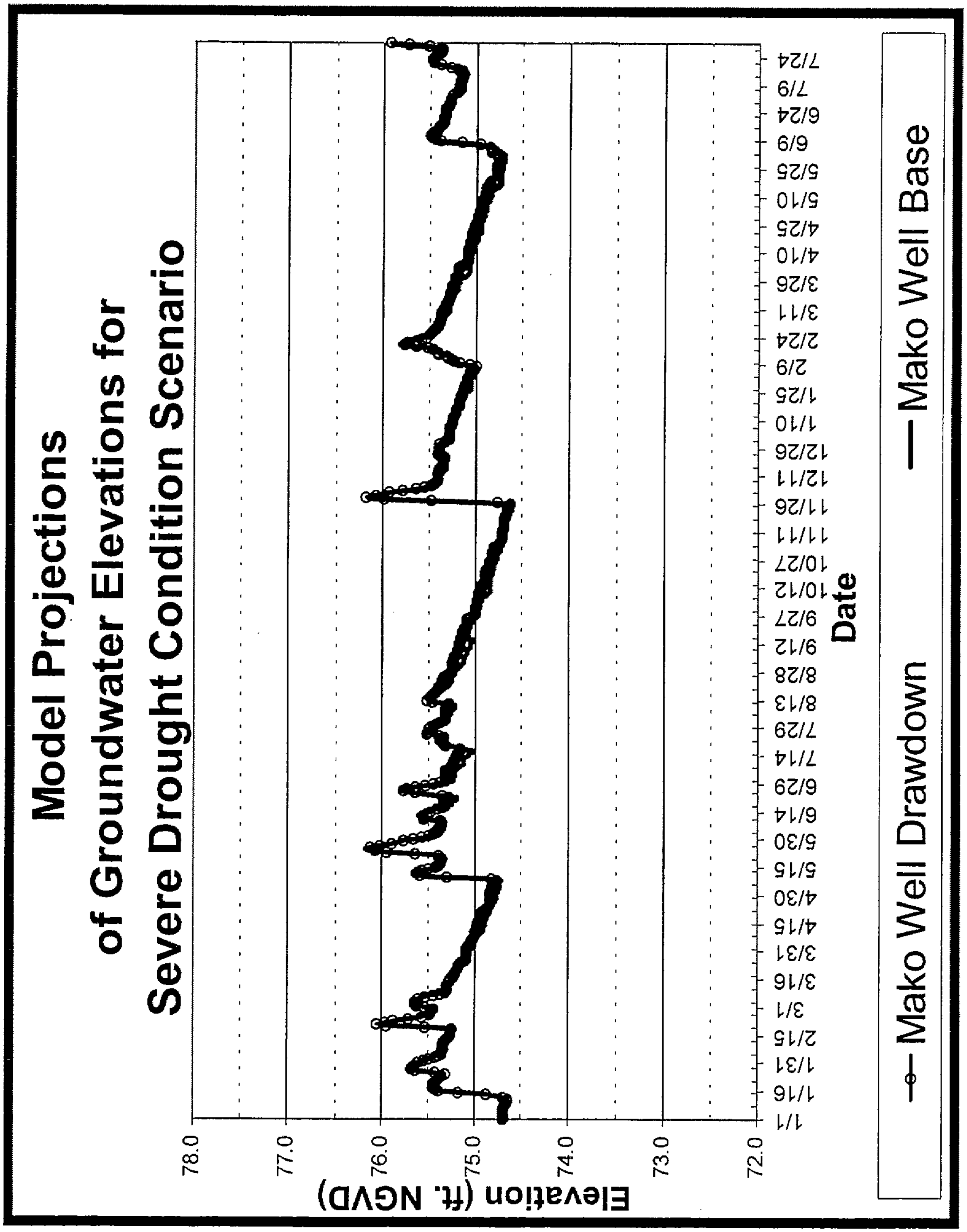
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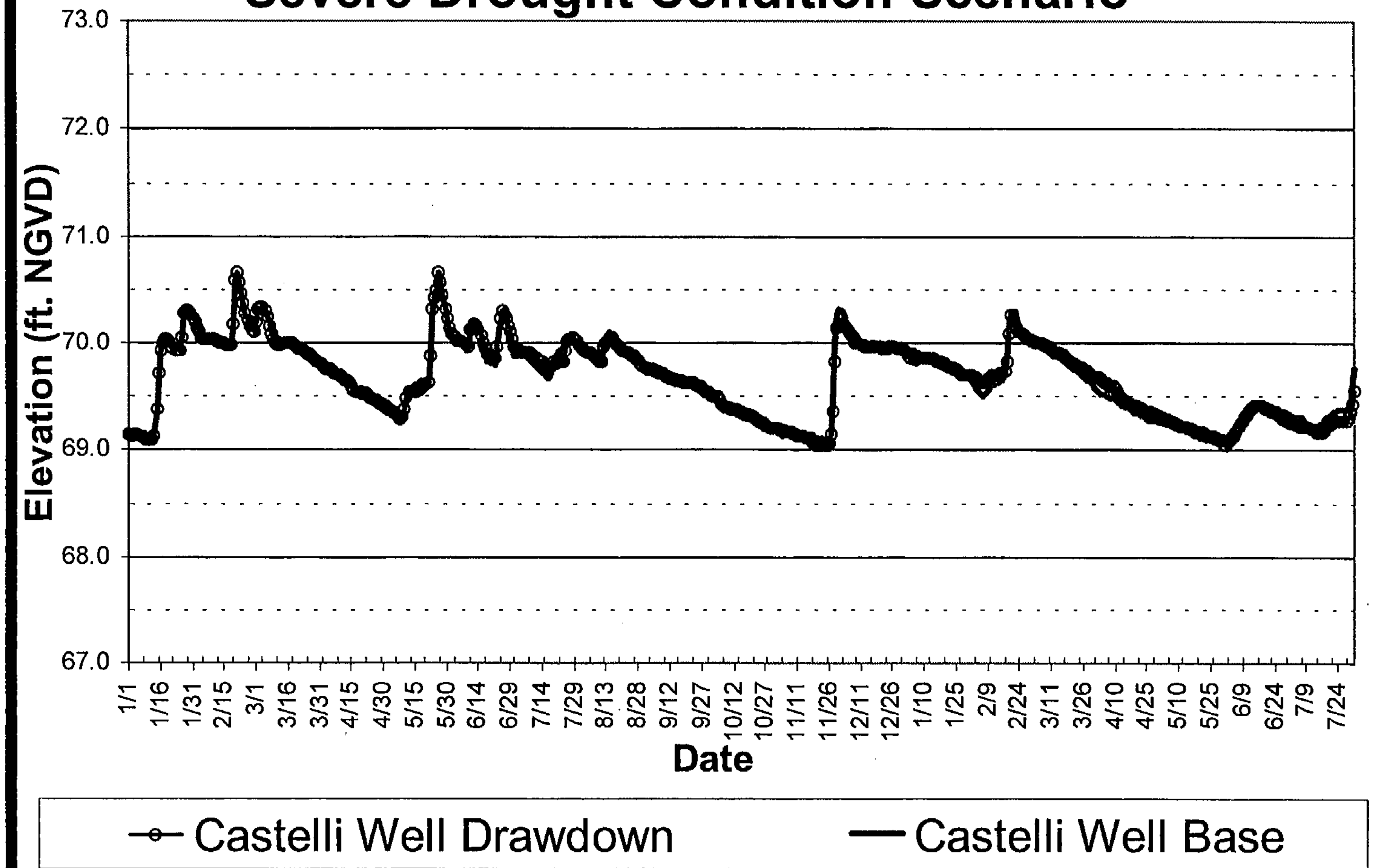
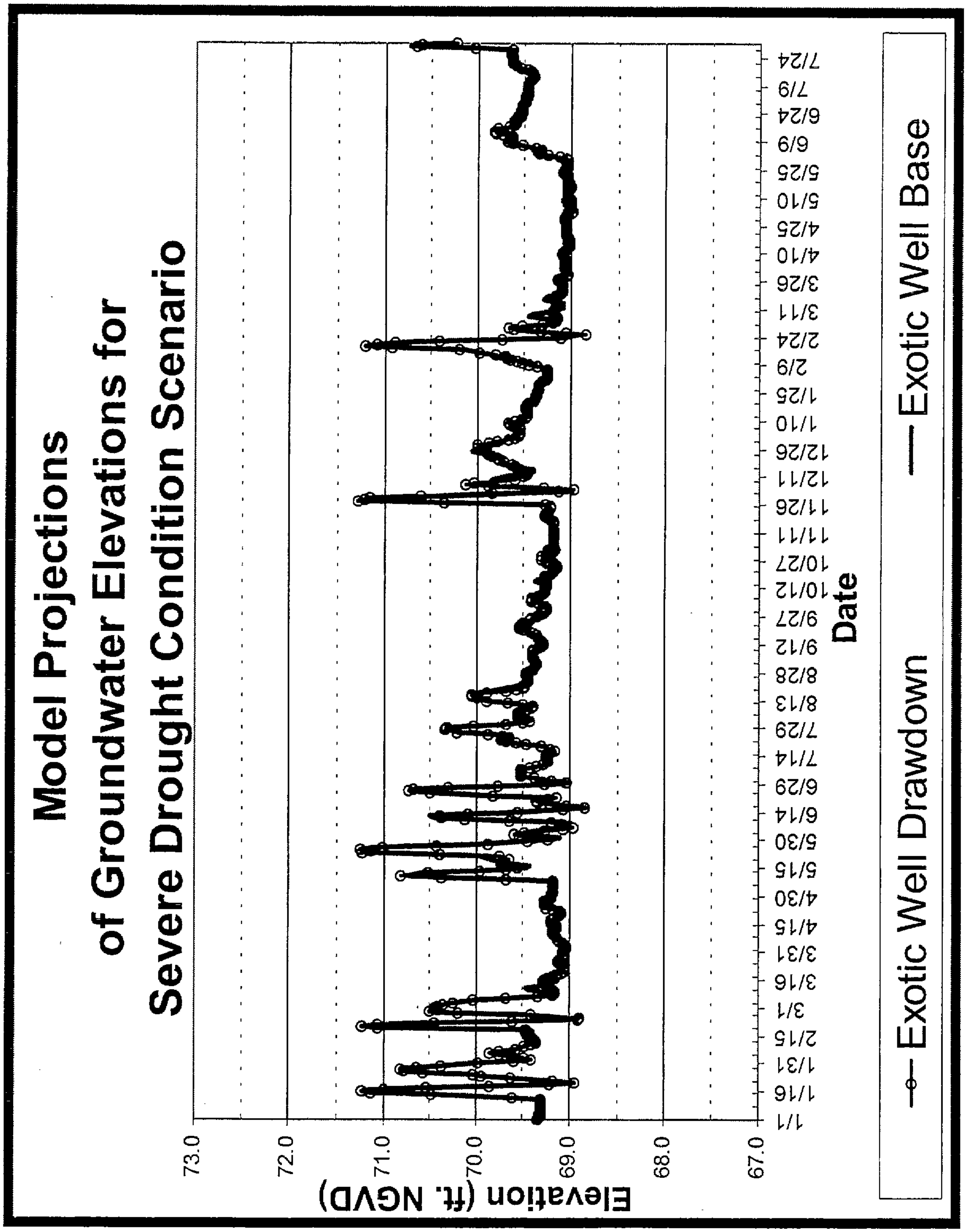
Mako Well Base

Model Projections of Groundwater Elevations for Severe Drought Condition Scenario

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Date
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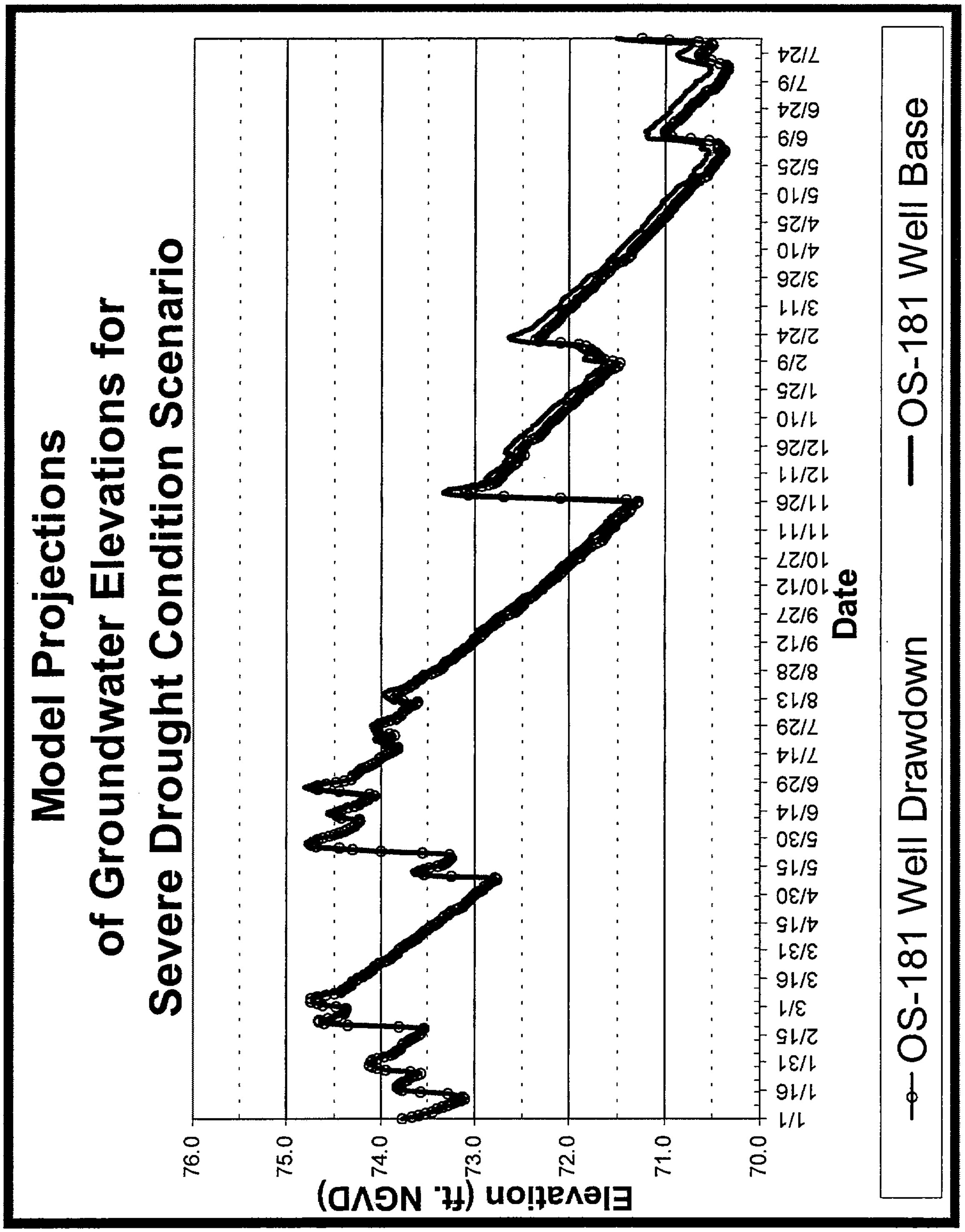
Exotic Well Base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Date
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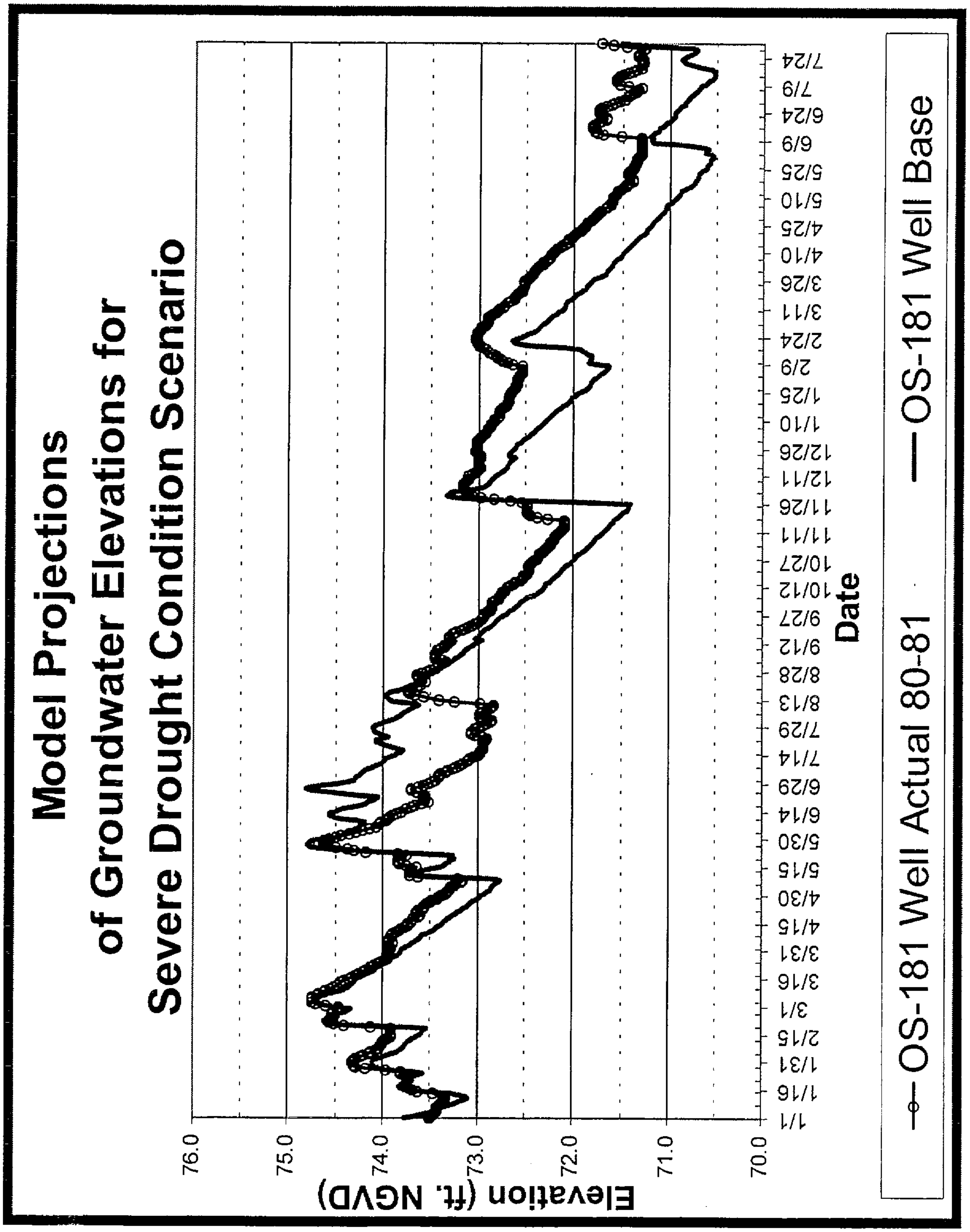
OS-181 Well Base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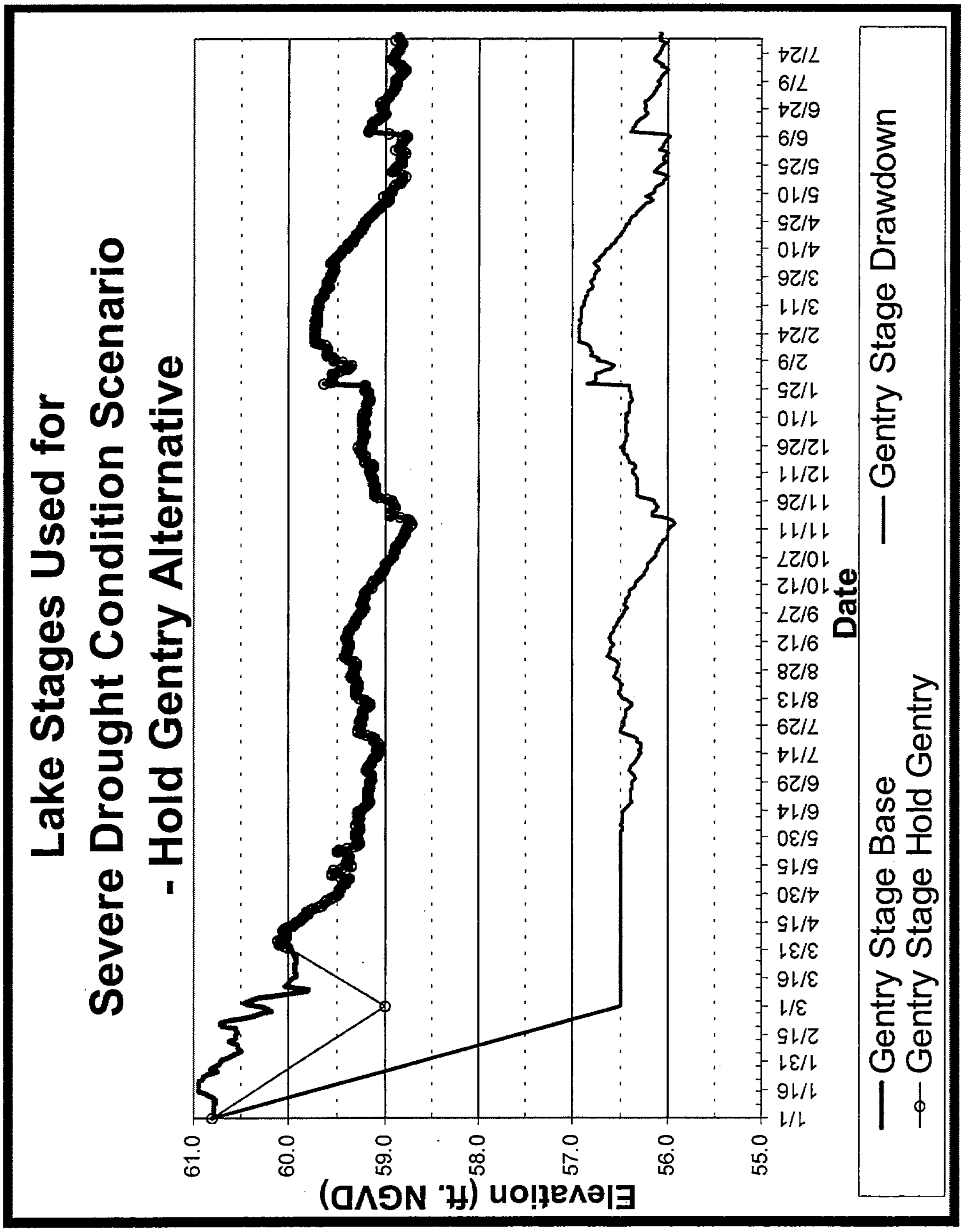
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Date
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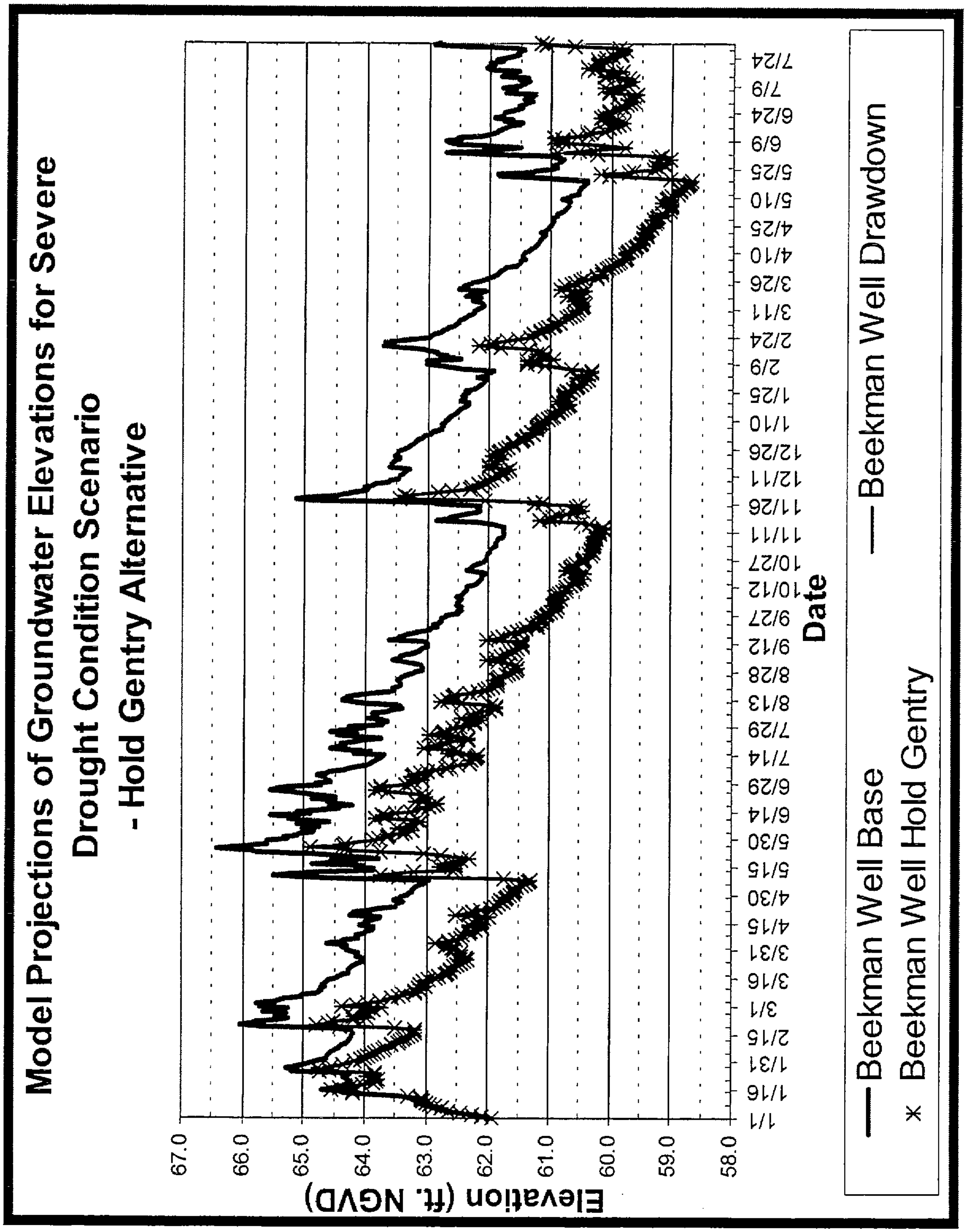
Gentry Stage Hold Gentry
Gentry Stage Drawdown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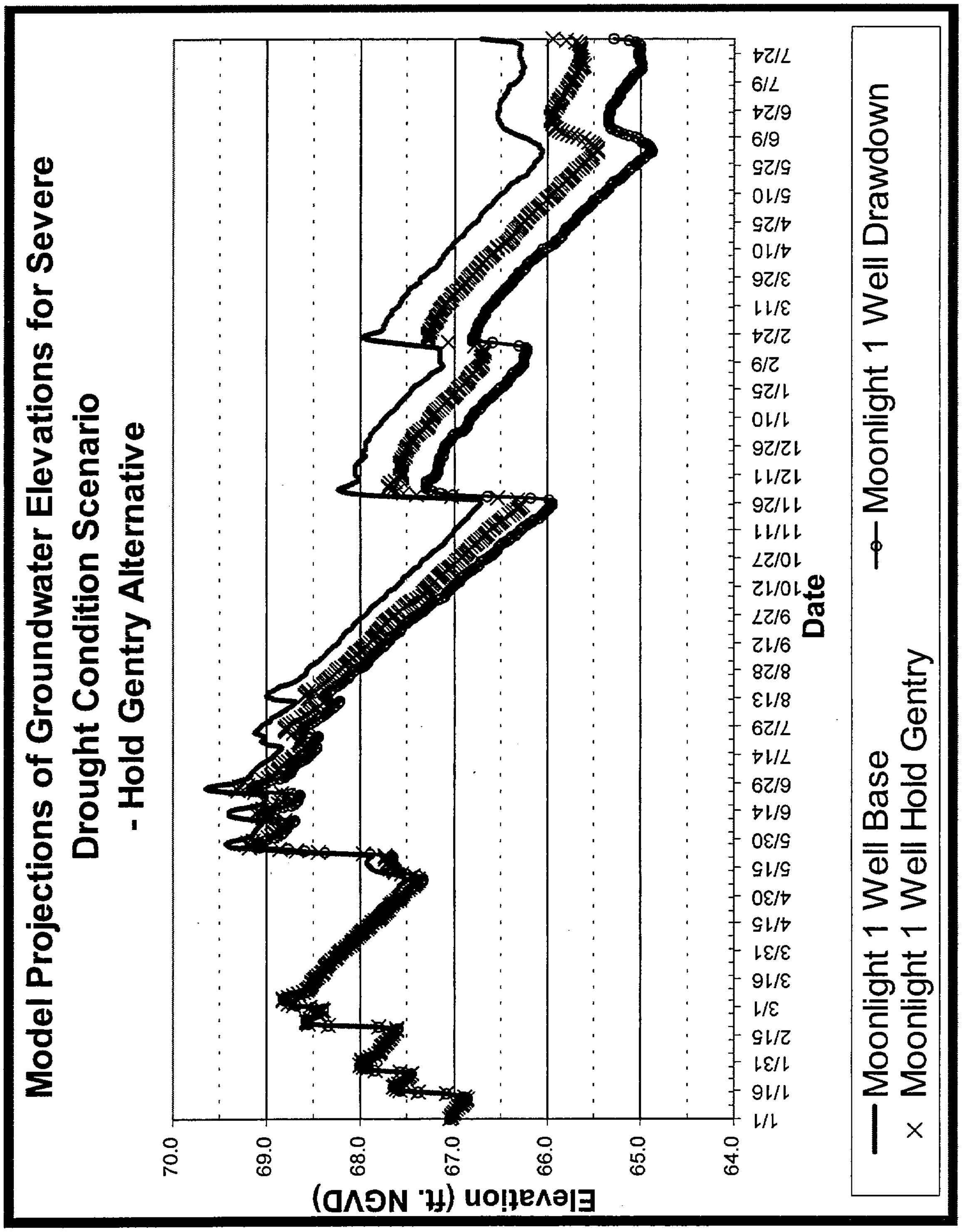
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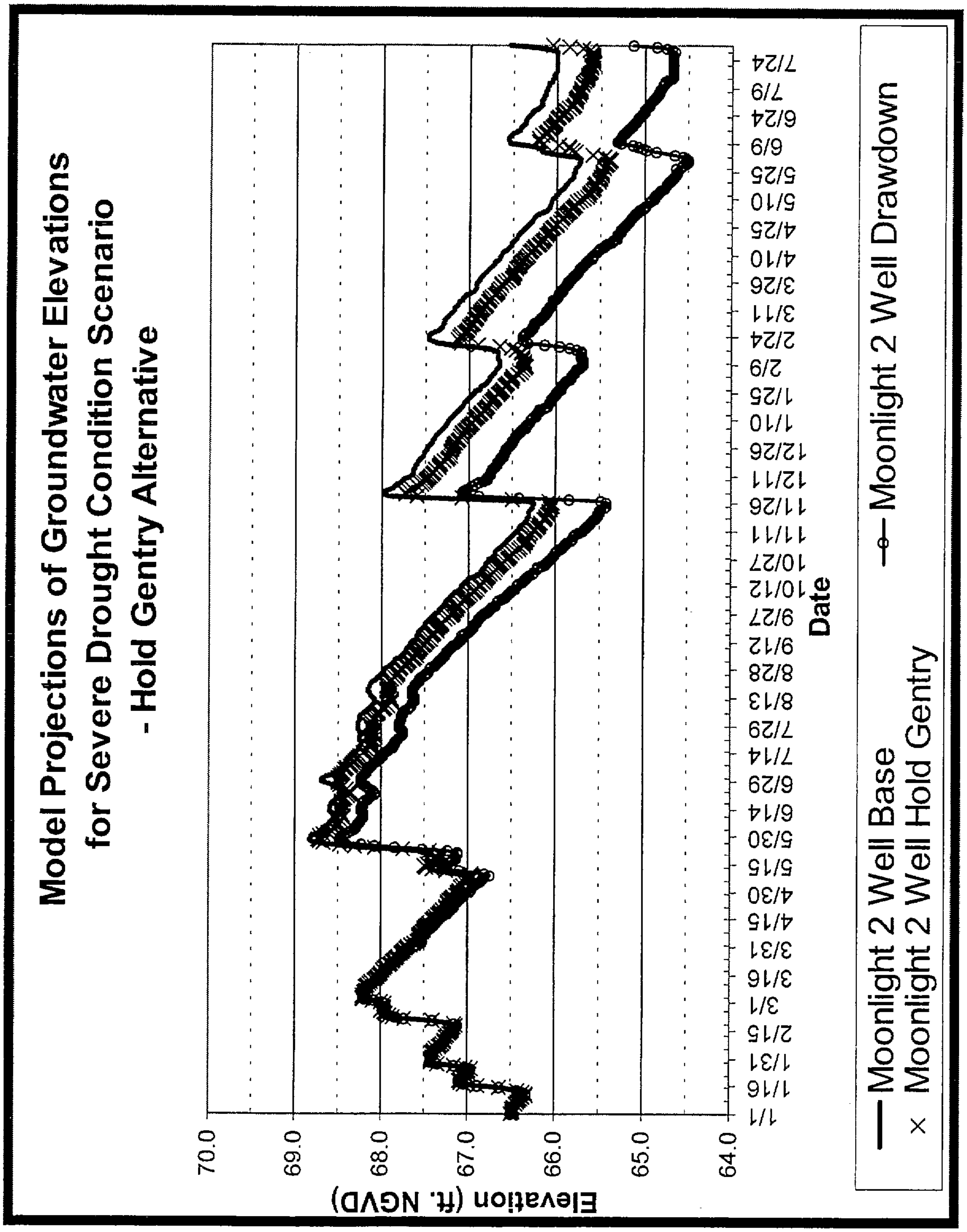
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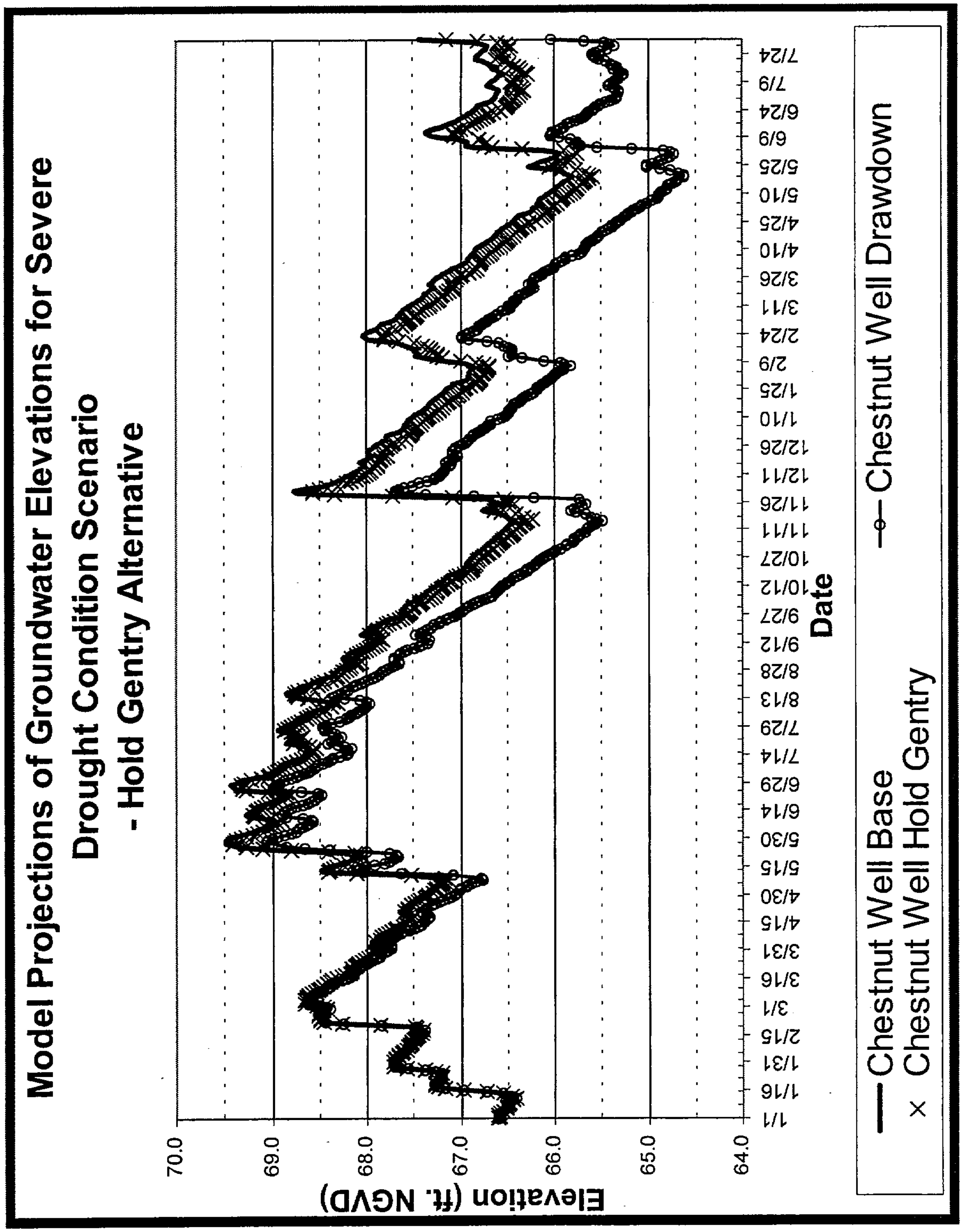

Model Projections of Groundwater Elevations for Severe Drought Condition Scenario - Hold Gentry Alternative
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Chestnut Well Base
Chestnut Well Drawdown
Chestnut Well Hold Gentry

Appendix M. Peer Review of Modeling Analysis

Peer Review of Modeling Analysis

The District Submitted the *Analysis of Projected Impacts of the Alligator Chain Drawdown Project on the Surrounding Water Table Aquifer - July 28, 1998* and the *Alligator Lake Drawdown Study Model Documentation - August 26, 1998* to outside peer review[1]. Three outside experts in hydrologic modeling were selected and sent the reports in December 1998.

The experts were asked to review the documents and provide comments. It was requested that their review specifically address the following questions pertinent to the theme of the study.

1. Have the groundwater / surface relationships in the study area been reasonably characterized?

2. Is the MIKE SHE modeling system an appropriate tool to use to analyze groundwater / surface interactions?

3. Is the methodology and approach used in this assessment sound?

4. Has the methodology been appropriately applied?

5. Is the data collection network in proper locations and is the data sufficient for the analysis?

6. Are the conclusions reached reasonable (accurate?) and supported by the analysis?

7. In your expert opinion has the project taken advantage of available groundwater / surface interaction assessment techniques/methodologies? Provide suggestions for future improvements of such assessments and design of data collecting systems. Please also provide suggestions on the application of such assessments in hydrologic-hydraulic modeling of alternative water management strategies for ecosystem restoration.

The following pages are the comments received from the peer reviewers.

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1. To increase the ease of the peer review, these two documents were combined in October 1998. The documentation report was included as Appendix L.

January 19, 1999

Ms. Nancy H. Urban
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

Subject: **Peer Review: Alligator Lake Drawdown Model**

Dear Ms. Urban:

This letter summarizes my comments on the report "Analysis of Projected Impacts of the Alligator Chain Drawdown Project on the Surrounding Water Table Aquifer." I have included some editorial suggestions on portions of the text, along with my technical comments. I've done this because the study addresses a potentially controversial topic, which may be perceived as impacting the economic interests of various parties. The results will probably be subject to close scrutiny and criticism, particularly if litigation should ensue. It is therefore important not only that the analysis be valid, but also that it be presented and explained in a manner which will pre-empt, or at least answer, any potential criticism.

My comments are presented below in three sections. Section A is a general critique of the model, its application to the question at issue, and the way it is presented and justified in the report. Section B provides specific comments on statements in the first part of the report (pages 1 through 10). Section C contains my responses to the questions posed in the Scope of Work for this review. I apologize for the repetition which has crept in, but I believe it's better to be repetitive than to leave something out. I have not made specific editorial comments on the material in pages 11 through 26 of the text; these pages provide a straightforward discussion of the procedures used to evaluate lake drawdown impacts, and present the results of those evaluations. The method used is logical, and the results are as good as the model itself; and my comments on the merits and limitations of the model are given in Section A.

A. General Comments on the Model, its Application, and its Presentation in the Report

My overall opinion is that the model is reasonable, and that the results of the analysis are correct. However, I believe the calibration should be strengthened through the addition of a steady-state analysis, the question of the specific yield of the surficial aquifer should be addressed, and the discussions in the report should be expanded to emphasize the ways in which the calculations yield conservative estimates.

The calibration described in pages 8 and 9 and in Appendix H was done entirely in the transient mode. The results are therefore probably sensitive to the specific yield assumed for the surficial aquifer. I found no mention of specific yield in the report or its appendices. I understand from the conference call that a uniform value of specific yield, 0.20, was used throughout the upper layer of the model. At a minimum, the report should give the value used, and present a rationale or justification, both for the use of a uniform value, and for the particular value that was chosen. I assume that the specific yield value was not determined through model calibration. If I'm correct in that assumption, we know that the calibrated hydraulic conductivity distribution gives satisfactory results if a uniform specific yield of 0.20 is used; we don't know if that conductivity distribution would work given a different specific yield or specific yield distribution.

During the conference call, the other reviewers mentioned the possibility of doing a steady-state calibration. I strongly endorse this idea, and note that it could do a great deal to resolve the specific yield issue. A hydraulic conductivity distribution based on steady-state calibration is independent of specific yield. If the conductivity distribution from a steady-state calibration turns out to be similar to that obtained in the transient calibration, the transient calibration can be taken both as confirmation of the hydraulic conductivity distribution, and as the basis (or at least one basis) for the specific yield value. I agree with Dr. Peralta that there is ample hydraulic information on which to base a steady-state calibration. In known swampy areas, for example, the calculated water table should be at land surface. It should never be above land surface, and in areas where the vegetation is known to require a certain root depth, the water table must be below that depth. General experience with excavations and the need for dewatering during construction can also provide information useful to a steady-state calibration. A further source of information might be known stream characteristics, e.g., whether a stream is gaining or losing within a particular reach.

In a steady-state calibration, the objective is generally to match a mean annual water level distribution, compatible with mean annual precipitation, or perhaps to match a seasonal mean water level distribution compatible with the average precipitation rate during that season. There will always be some uncertainty associated with the results; in many cases, however, it will turn out that the conductivity distributions which can give satisfactory results are limited to a relatively narrow range. While a steady-state calibration would do a great deal to resolve the specific yield question, I would recommend it whether or not specific yield were an issue, simply for the added confidence it would provide in the conductivity distribution. My sense from the conference call is that everyone was a little uneasy with the reliance on transient calibration alone, and that confirmation through a steady-state calibration would give everyone a lot more confidence.

To return to the specific yield question, an alternative (or additional) approach would be to test the sensitivity of the calculated drawdowns at the fish farms to variation in specific yield, for the various scenarios assumed in the analysis. If the conclusions turn out to be the same regardless of the simulated specific yield distribution, and if that point is clearly brought out in the text, a strong rationale for a particular value would be unnecessary.

In general, one would expect drawdowns to spread more rapidly and widely the lower the specific yield, other factors remaining equal. The value that was used, 0.2, is not particularly high, especially for sandy materials and for periods of drainage measured in days or weeks. So an argument could certainly be made that this represents a conservative value. This argument could be further strengthened by noting that in swampy areas the specific yield may be much greater than 0.2, and may even approach unity. For example, if the surface of a swampy area is 50 percent soil having a specific yield of 0.3 and 50 percent open water, for which the specific yield is one, the weighted average specific yield would be 0.65. I'm not sure what fraction of the model area is represented by swamps, or what the percentage of open water within the swampy areas may be; but in any case, as I understand the simulations, these areas were not treated any differently from other parts of the aquifer. That is, they weren't represented as surface water bodies or as areas of high specific yield, or anything else. If they had been so represented, the calculated drawdowns at the fish farms would have been smaller. So if my interpretation of what was done is accurate, and if swampy areas make up a significant part of the study area, the use of a uniform specific yield value of 0.2 is highly conservative.

Another respect in which the model calculations are almost certainly conservative is in the use of a single model layer to represent the surficial aquifer. The text touches on this, but the issue merits much more emphasis. While this is primarily an editorial concern, rather than a technical issue, some technical points seem to have been neglected here; and again, no matter how valid the simulation results may be, the entire effort could be wasted if the analysis is not presented in a convincing manner in the report. In any case, because interaction between the surficial aquifer and deeper layers is apparently minimal, representation of the surficial aquifer as a single layer means that the analysis is essentially two-dimensional. For many (if not most) purposes this would be a limitation, but for estimation of the effects of lake drawdown on the fish ponds it represents a conservative approach. Saturated thicknesses are on the order of 100 feet in the surficial aquifer, and the lakes are represented as model boundaries. Thus unless something special was done along the boundaries, the lakes were simulated as fully penetrating the surficial aquifer, with no intervening resistance term. I'm not aware of actual depths or bottom conditions at the lakes, but it seems probable that they are partially penetrating, and that they are separated from the aquifer at least by a layer of typical organic lake bottom sediment. If this is the case, drawdowns in the aquifer adjacent to a lake would necessarily be less than the